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THE

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OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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General.—The laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute, Talawakelle. Telegraphic address: RESEARCH, TALAWAKELLE; Telephone: Talawakelle 44 (Private Exchange).

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Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.

THE TEA QUARTERLY

VOLUME XXX MARCH, 1959 PART 1

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SUNSHINE RECORDERS

Will Superintendents of estates which have a Sunshine Recorder in working condition or otherwise, please contact the Plant Pathologist of the Tea Research Institute and give him particulars about the apparatus?

A. W. R. JOACHIM,
Director,
Tea Research Institute of Ceylon.

GUATEMALA GRASS MANURE MIXTURE

There has, unfortunately, been some confusion over the composition of the revised Guatemala Grass Manure mixture. The correct formula will be found on page 252 of *Tea Quarterly*, Volume XXIX, September/December, 1958.

J. A. H. Tolhurst,
Agricultural Chemist.

EDITORIAL COMMENT

The chief features of interest which this issue of the *Tea Quarterly* contains are an account of the visit of a delegation from the Tea Research Institute of Ceylon to the tea-producing areas of Georgia, U.S.S.R., a statement of the general principles of soil cultivation and of manure application to tea, the effect of marigolds and some other crops on the eelworm populations of tea soils, and the timing of blister blight spraying according to sunshine records.

Tea Cultivation in Georgia, U.S.S.R.

But little reference need be made to the first of these features except to point out that the article throws much light on the considerable importance paid in the U.S.S.R. to research on the commodity, both from the cultivation and manufacturing stand-points. The other three articles call for comment because of their useful contributions to our knowledge of the optimum conditions of tea cultivation in the Island.

Principles of Soil Cultivation & Methods of Manuring Tea

The review by Mr. Tolhurst on the principles of soil cultivation and methods of manure application to tea serves to bring to the notice of the planting community his views and recommendations on different aspects of these subjects, in regard to which he has frequently been asked for advice. It is intended to serve as a general guide to cultivation problems, and will not necessarily answer specific questions or apply to particular conditions. Accordingly, he would welcome comments on specific points and be glad to clarify any matters at issue. The note by this writer on his revised recommendations for the application of dolomite and magnesium sulphate to tea should also prove of interest and value to the increasing number of users of these materials as means of supplying magnesium to the crop, where it is needed.

Marigolds & Eelworm Control

In his account of the influence of marigolds (*Tagetes* spp.) and other crops on meadow and root-knot eelworms of tea, Dr. T. Visser affords clear evidence of the beneficial effects of varieties of marigolds in reducing the harmful eelworm populations affecting tea. He also furnishes confirmation of one advantage of using Guatemala grass for rehabilitating derelict tea lands, namely, the adverse effect it has on eelworms parasitic in tea. In view of the practical applicability of these methods of eelworm control, it is hoped that they will commend themselves, for trial at any rate, to those estates where the "disease" is prevalent and affects crop yields to varying degrees.

Sunshine Records & Blister Blight Spraying

The paper by joint authors summarises the investigations started by Dr. Visser and his associates on a new method of timing blister blight spraying according to sunshine records. The authors show that a spray-timing system based on an average daily sunshine of 3 to 4 hours' duration recorded over 5 to 7-day periods, provides adequate protection to the crop and, at the same time, appreciably reduces the number of copper fungicide sprayings and hence the cost of blister blight control. This work is by no means complete and a number of trials to test the method on a field scale is being carried out on various estates. Until these have proved satisfactory and the practical difficulties involved have been solved, the method cannot be recommended for adoption on estates; but there are grounds for hope that it might eventually prove successful and practicable.

"Oilspot" — a New Disease of Tea?

A preliminary investigation by Dr. Mulder and Mr. Shanmuganathan will bring to the notice of estate Superintendents in the higher elevation ranges, a hitherto undescribed disease now named "oilspot" or "spotted leaf" disease. The Institute would welcome any information which Superintendents might furnish in regard to the occurrence of the disease.

Miscellaneous

The attention of readers may also be drawn to the brief note by Mr. E. F. W. Fernando of the Entomological Division on the method of storage of the ambrosia fungus (*Monacrosporium ambrosium*) by the female of the shot-hole borer beetle, which is apparently different from the methods adopted by other species of ambrosia beetles.

On the manufacturing side, factory managements would be interested in the report by Mr. Keegel on a new type of moisture tester which has been tried out by him and found to give satisfactory performance and to be relatively easy of operation.

REPORT ON THE VISIT TO THE TEA PRODUCING AREAS IN GEORGIA, U.S.S.R., BY A DELEGATION FROM THE TEA RESEARCH INSTITUTE OF CEYLON

Origin of the tour

Following upon earlier visits from two delegations from the U.S.S.R. the Ceylon Government was invited to reciprocate by sending a delegation from Ceylon.

This was led by Mr. B. Mahadeva, the Tea Controller, and consisted of:

Messrs. F. Amarasuriya, Chairman of the Tea Research Institute Board, two members of the Board of Control, Messrs. W. H. W. Coultas and N. M. Sanders, two officers from the Tea Research Institute, Messrs. E. L. Keegel, Technologist, and F. H. Kehl, Vegetative Propagation Officer of the Department of Plant Physiology. Also attached to the delegation was Mr. J. Wagiswara as official photographer.

Objects of the tour

To study, within the limits made available, the methods of tea growing, cultivation and manufacture generally adopted in Georgia, U.S.S.R.

Arrangements for the tour

This was on an entirely Government to Government basis, and in Moscow the delegation was appraised of the programme which had been drawn up by the officials of both the Agricultural Department and that of the Scientific and Technical Co-operations of the U.S.S.R.

We would take this early opportunity of thanking most cordially all those connected in any way in drawing up these arrangements.

The general ground covered by our tour in the tea areas is indicated by the following summary of the itinerary:—

Friday,	September 5th	—	11 a.m.–1 p.m. Talk at the U.S.S.R. Ministry of Agriculture.
Monday,	September 8th	—	12 noon–3 p.m. Visited tea packing factory.
Tuesday,	September 9th	—	Left Moscow at 12-05 p.m. by 'plane. Arrived at Tbilisi—4 p.m.
Wednesday,	September 10th	—	11 a.m.–3 p.m. Tea packing factory. Left by train—10 p.m.
Thursday,	September 11th	—	Arrived at Maharadze 9 a.m.; 12 noon–5 p.m. Tea Industry. Institute in Maharadze region. Laitursky Tea Estate Farm. Saw mechanical plucking.

Friday,	September 12th	—	11-30 a.m.–5 p.m. All Union Scientific Tea Research and Sub-Tropical Crops Institute. Inspected Experimental Plots. Notanebi Stalin Collective Farm. Left for Batumi by car 8 p.m.
Saturday,	September 13th	—	Batumi. Visited Botanical Gardens.
Sunday,	September 14th	—	12-30 p.m.–2-30 p.m. Breeding Station at Chakwa.
Monday,	September 15th	—	10-30 a.m.–5 p.m. Achwiniskay's Tea Factory Kalinin Collective Farm. Left by night mail.
Tuesday,	September 16th	—	Tbilisi.
Wednesday,	September 17th	—	Left for Moscow by 'plane. Concluding talk at the U.S.S.R. Ministry of Agriculture.

The time afforded to the various Research Institutes was unfortunately short, and although it was suggested that more time might be required, no deviation from the official schedule was permitted.

Before giving a more detailed description of matters of particular interest, here follows a short general account of conditions in Georgia relating to the tea industry. Much of this information was supplied to us by the Ministry of Agriculture in Moscow.

Cultivation of tea in Russia began about 1890 but serious development only commenced after 1926, and at the time of our visit the area under cultivation was about 149,000 acres, of which 90% is grown in Georgia and the balance in adjoining Republics.

88% of tea is grown on 700 collective farms (Kolkhoz) and 12% on 32 State farms (Sovkhoz).

Production

Production in 1957 was 70½ million lb. including 13 million lb. green tea. On a rough calculation this amounts to 480 lb. made tea per acre. In terms of productivity the U.S.S.R. tea industry is therefore only between one-fifth and one-sixth that of Ceylon.

Imports in 1957 amounted to 46 million lb. chiefly from India, China and Indonesia. During the same period 11 million lb. were exported to the East European countries.

Target

It is proposed to increase production to 105/106 million lb. as soon as possible, by the opening up of further land so as to reduce the level of present imports.

Consumption

This is still rising and is in the region of 106 million lb. This is equivalent to 9 ozs. per head per annum for the whole of the U.S.S.R. The highest consumption in any Republic is said to be approximately 3¼ lb. per head per annum.

Climate

This is sub-tropical and unlike Ceylon, it has periods, from November to the end of February, when temperatures often fall below that of freezing point, restrict-

FIG. 1.—A typical view of the tea country.

FIG. 2.—Plucking tea.

ing growth to such an extent that no leaf is harvested. However during the months of May to September, the climate is such that very vigorous growth is obtained, which makes possible the harvesting of yields in certain of the more favourably situated districts, of up to 1,000 lb. per acre.

Rainfall in the areas which were visited averaged between 85″ to 100″ per annum of which a part falls in the form of snow.

Distribution is fairly even but in the North-Western regions, where rainfall is considerably less, irrigation is resorted to.

In summer the temperatures may rise as high as 85°F. and in the Batumi area, which is one of the mildest, may drop as low as 22°F. in winter.

Average humidity during the summer is about 80%.

Soils

Those in the low hills and plateaus, consist of red Podzolic soils, with rather heavier and clayey sub-soil, which would, it was thought, require adequate drainage, but the absence of drains as known in Ceylon, would show this to be not the case.

The soils throughout the region are acid, with pH ranging between 4.5 and 6.

Jat

The original seed was imported from China, Japan, India and Ceylon, but general preference, however, has been given to low hybrids as being better able to withstand the rigours of the winter, than the large leaf Assam varieties. For this very reason great attention has been given to the subject of plant breeding, with the object of raising types of seed which could combine resistance to adverse climatic conditions and high yields. This subject is referred to later in this report.

Clearings and Planting Methods

Most of the tea is planted on flat land and some on gentle slopes of hills. No land with a gradient of over 30° is cultivated with tea, as it is considered that the planting of steeper land would result in much soil erosion and ultimately become uneconomic. The elevation ranges from almost sea level to about 1,500 feet. In view of the heavy sub-soil the cleared land is usually ploughed to a depth of 16–20″ after which a crop of lupins or soya beans are grown in the year prior to planting.

Tea is planted in continuous hedges on the contour, with planting distances approximately 5′ × 1¼′ or even less on steeper land.

Seed, provided from the Tea Breeding Centres, form the planting material, at the rate of 4–5 seeds per hole. This is ungerminated and planted approximately 1¼″ below the ground level. Bush density per acre is between 6,000–8,000.

The reason for planting 4–5 seeds per hole is that it is considered the roots of the plants fuse together resulting in a better top growth, whilst the root mass produced, maintains the soil in better condition than single plants.

Seeds are sown in March, manually. It was understood that whilst V.P. material had been tried out, it had been found that for biological and economical reasons, seed provides a more satisfactory medium of planting material.

Growth is comparatively slow, with young plants coming into bearing after four years and in full production after seven.

Treatment of Young Plants

These are given the first cut or centering at approximately 4″ to 6″ which is generally in the third year, and twelve months later, a further cut across at between 13″ to 15″. This is adequate to produce good bush formation, particularly in view of the technique of multiple seed planting.

Pruning

Bushes in full production are subjected annually, in February or March, to what is best described as a light cut-across or skiff. This is done by hand shears, and in some cases, where the lie of the land permits by machines. The bushes are dome shaped which it is contended gives a larger plucking surface, and the light skiff is referred to as "bush forming." This, as far as could be seen, maintains the overall size of the bush, which, in subsequent years, varies but little.

A medium prune is, however, carried out once every 10–15 years, when the bush is cut below the level of leaf growth, and a heavy prune to within six inches of the ground is made once in every 25 years or thereabouts.

There is we believe very little tea, which has received this latter treatment.

The medium and heavy prunes are done with long-handled shears.

Plucking

Considerable care is taken to ensure that leaf of high quality is sent to the factory.

At the beginning of the season the plucking is light, *viz.* two leaves and sometimes even three being left above the fish leaf, but by June this has been reduced to one, and in July even this is plucked. This may account for the very small increase in bush size each year.

Very coarse plucking is adopted in November for the production of brick tea.

Plucking standards compare favourably with those in Ceylon and every effort is made to maintain 7–8 day rounds during the height of the cropping season. On numerous occasions pluckers were to be seen working late hours in the long summer evenings.

Much research has been expended on devising suitable machines which will pluck tea with the same degree of selectivity as when done manually. The machine demonstrated goes some way towards achieving this, and by means of projections on the under side of the cutters, a proportion of the young tender shoots are depressed and so pass under the cutter.

The cutter spans the width and conforms to the shape of the bush. The cut shoots are drawn by suction into a container. The machine requires two operators and is said to be capable of cropping 12 acres per day.

The cropped leaf is naturally less even than that plucked by hand, but where labour is short, this machine will be found to be useful. It would be safe to say, however, that only a small acreage is plucked in this way.

Leaf weighing centres are distributed throughout the tea areas and the leaf is sent from these to the factories in shallow wooden boxes 3 times a day. Each centre is in charge of an Agronomist.

The degree of stalk is assessed by a leaf count whilst the percentage of surface moisture is determined by a somewhat crude method.

FIG. 3.—Mechanical plucker.

FIG. 4.—Mechanical plucker in operation.

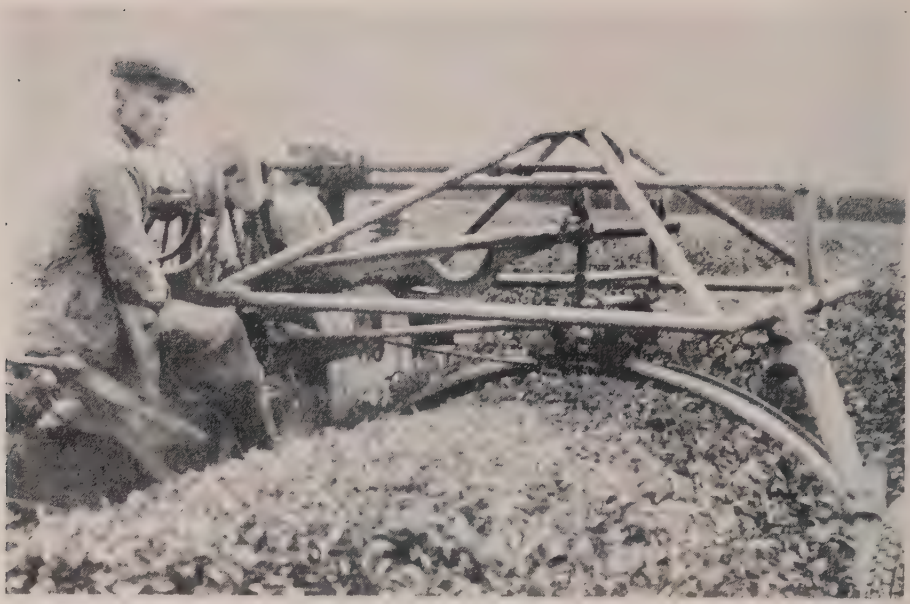


FIG. 5.—Mechanical trimmer being used for "bush forming."

FIG. 6.—Mechanical manuring of tea.

Cultivation and Manuring

Apart from the initial sub-soiling carried out preparatory to planting, no subsequent cultivation is deeper than 5–6 inches. At the Experimental Station an excellent cover of tea was seen which had received no cultivation for the past 10 years and opinion tends to favour less and less in the way of soil disturbance, it having been established that deeper cultivation depresses yield.

Mixed fertilizers, as used in Ceylon, are not applied. The application of Nitrogen is made biannually in March and June, followed by one application of Potash in April, whilst Phosphate is given only once in 4 years.

In general, we were given to understand that manuring levels were tied to yields, but as the quantities varied from district to district, and soil conditions being so different from those in Ceylon, little useful purpose would be served by giving details of the amounts supplied. It would, however, appear that the ratio of 8 lb. N per 100 lb. crop removed forms the general basis of manuring.

Nitrogen is supplied in the form of Sulphate of Ammonia, and/or Ammonium nitrate. The latter being preferred where acidity is low.

Phosphoric acid is added in the form of Superphosphate or phosphate meal.

Potash is supplied as Muriate of Potash.

The manure applications are broadcast in both rows, either manually or by machine (still experimental) followed by light cultivation.

In places where soil structure is poor, we were informed that heavy applications of peat moss, up to 80 tons per acre, are applied once in 4 years.

Weeding

This does not appear to present a problem, and is adequately controlled by light hoeing 4–5 times a year. In the collective farms ferns were a common sight as well as other Ceylon varieties of weeds, such as *Polygonum nepalense* and *Agoratum*. Whilst species of paspalum were noticed little if any couch grass appears to exist in the tea areas.

Green Manuring

The absence of trees of all description within the tea areas was most striking. It is considered that the normal leaf-fall together with that obtained by the annual bush framing operations supply sufficient replacement of organic matter to the soil. Reference has already been made to the periodical application of peat.

Wind Belts

Considerable attention has been given to the protection of the tea from the effect of winds by the provision of suitably spaced wind belts of the species *Cryptomera Japonica* which grow up to a height of 40–50 feet.

Pests and Diseases

There appears to be no serious leaf, stem or root disease in the tea, and the most serious pest is that of the scale insect *Pulvinaria flocciferrae* which attacks leaves and stems. It is however not widespread and is said to be adequately controlled by chemical means.

Manufacture

The delegation visited the Arch Winskia Tea Factory, the largest of 63 factories in Georgia, which was built in 1951.

The main structure was of masonry walls with timber roof tiles and differed entirely from the standard Ceylon factory.

It had an output of 1,250,000 lb. made tea per annum and was said to be typical of most tea factories in Georgia. The average daily green leaf intake was 60,000 lb. The equipment was adequate for 100,000 lb. approximately, and anything received in excess of this figure was sent to other factories in the vicinity.

No expense seems to have been spared in the building of this factory, which cost Rs. 15,000,000/ - inclusive of equipment. A striking feature was its spaciousness and cleanliness. Boards in prominent places stressed the necessity for hygiene, and the whole building, including the laboratories, where moisture content and analyses were carried out, gave the general appearance of being well kept.

As in Ceylon each process is carried out in a separate section of the factory. The traditional withering lofts were absent and in their place were withering machines situated on the first floor. These were fed with green leaf by means of conveyer belts running from the ground floor.

The leaf, after withering, was subsequently charged into rollers through chutes as in Ceylon. The rest of the processes were carried out in exactly the same way as in orthodox manufacture.

Leaf was received 3 times daily. On heavy cropping days it was not unusual for manufacture to go on continuously in three 8-hour shifts. Motive power was electricity supplied from a grid and furnace oil was used for firing. The electric power required per pound of tea manufactured was, we were told, 0.25 units. Manufacture was carried out on about 150 days in the year.

A striking feature of the establishment was the large number of staff employed despite the fact that machines were used for withering and the whole process from the time the leaf is received up to the time of charging it into the rollers, is almost fully mechanized. Besides nearly a 100 factory workers, the majority of whom were women, there were 12 executives, 4 accountants, 3 tea tasters and 18 technologists and laboratory technicians.

The equipment consisted of:

2 withering machines.
18 36″ D.A. rollers (modelled after Marshall's machines with Jacksons battens).
3 roll-breakers.
2 humidifying plants.
4 5′ E.C.P. driers similar to Marshall's driers.
2 sifters.
1 cutter.
1 blending drum.

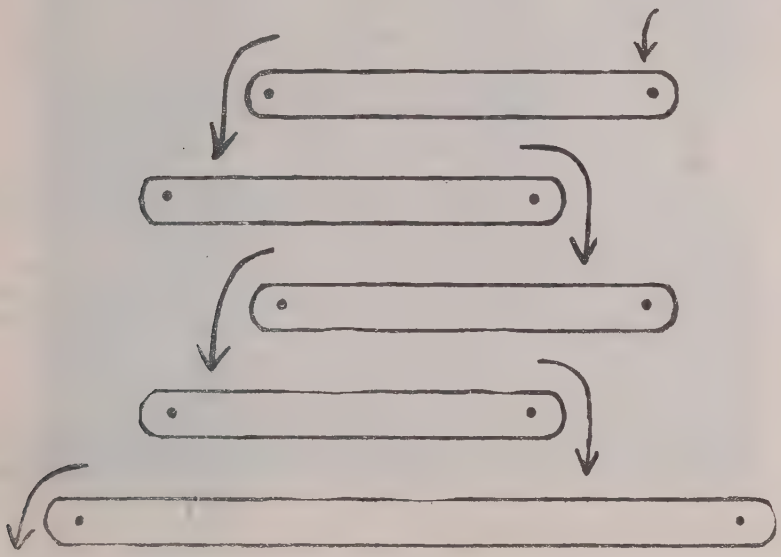
This amount of machinery cannot be considered excessive for an average daily output of about 15,000 lb. made tea.

The method of manufacture appeared to follow closely that adopted in Assam—namely light withers, light rolling and double firing. Evidently the main objective is the preservation of aroma and good appearance of the tea, to which much importance is attached.

(*a*) **Withering.**—Withering machines are employed in the main which function on a similar principle to that of an ordinary drier. The air movement inside the

chamber is somewhat intricate, but otherwise the movement of the leaf through the chamber is quite simple. The leaf is moved forwards and backwards on endless wire mesh trays just as in any E.C.P. drier, the only difference being that whereas in the latter the material falls from one tray to another by a tilting of each moving tray, the leaf in the withering machine falls directly on to another endless web of wire mesh. The general arrangement is as under:

Inlet



Discharge

The machine is stated to have an intake of nearly 2,000 lb. green leaf per hour and is normally operated at temperatures between 110°F.–150°F. Under these conditions the leaf takes 3 to 5 hours to wither and is discharged with a moisture content of over 60%.

For the method of manufacture adopted in the Soviet Union the machine undoubtedly serves its purpose and it could possibly be used with success in certain low-country factories in Ceylon as an alternative to the withering drum, when additional withering space is required. Unlike the withering drum, however, the machine seen in Georgia did not discolour or bruise the leaf.

(*b*) **Rolling.**— Three 45 minute rolls are carried out, with no pressure on the first rolls, and light pressure in the remaining two. As a result, the big-bulk percentage is unduly high and may account for more than 50% of the initial charge.

The rollers are all of the Marshall's D.A. type, and appeared to be running at a speed of over 60 r.p.m.

The rollers used for the first charge were opened top to facilitate feeding. The tables were free of battens except for the finger battens on the 4 sides of the well. The doors were of the sliding type which precluded centre cones or other fitments. The tables were deep resulting in no spillage over the periphery.

In rollers with pressure caps, pressure was mechanically applied by a drive taken off one of the roller cranks. This appeared to be satisfactory, but somewhat slow in operation.

The rolling room itself was humidified by a system not unlike the Vortex system, which discharges moistened-air through spraying nozzles and which is still used in some Ceylon tea factories. Mean temperature in the rolling room was 70°F. and 95% R.H. aimed at.

Rolling room organization as we know it in Ceylon was lacking.

Leaf, after roll-breaking, was carried to the rollers in trolleys and thereafter fed into the rollers by means of close tine pitch forks. The method appeared quite satisfactory.

(c) **Roll-breaking.**— The machines used are similar to ours except for the following features

(i) No. 3 brass mesh.

(ii) No ball-breakers.

(iii) The legs are positioned above the trays, being hung from a cross gantry. By this means there was no obstruction to leaf collection under the trays.

(*d*) **Fermentation.**— This process was carried out in a separate room maintained at the same temperature and humidity as in the rolling room. On the day of our visit, temperature readings were: 72°F. (dry), 68°F. (wet), which represents a relative humidity of about 80%.

Leaf was fermented in wooden troughs, which were steamed daily. The period of fermentation was between 3 and 4 hours.

In a laboratory attached to the rolling and fermenting room, assistants carried out periodical tests of the T.O.M. and water soluble extract of samples of rolled and fermented leaf; what this data was expected to reveal and how fermentation was controlled thereby was not quite clear.

(*e*) **Firing.**— The driers are modelled after the earlier Marshall's machines and possess 8 trays each.

Double firing was carried out as in N.E. India, the first operation taking 25 minutes and the second 15 minutes, the firing temperature being 180°F. and 200°F. respectively.

It was interesting to note that on the driers as well as in the furnace room there were meters to register the flow of air as well as the normal recording thermometers. Some of these, however, were not functioning.

Moisture content of the teas was determined by ordinary oven methods.

(*f*) **Grading.**— Particular care was taken throughout all stages of grading, resulting in excellent separation of the made teas. The principal sorter comprised 2 parallel trays, on the same plane, supported from an overhead gantry and driven by a central single crank which imparted a rotary action similar to that of a Chota Moore.

Great attention was paid to the removal of fluff and dust by means of elaborate extractor plants, and the general hygienic conditions were of a high standard.

The larger particles of leaf (the big bulk chiefly) were reduced in size in a machine operating exactly as our cutters but the cylinders, instead of having cells are grooved, as a result of which no knives are needed. In consequence the teas were inclined to be crushed because of the breaking action.

On account of a complicated system of grading and nomenclature it was not possible to obtain any accurate information on grade outturns. Prior to packing,

FIG. 7.—Rollers with open tops—used for the first rolls.

FIG. 8.—Roll-breaker—showing the legs positioned above the tray.

teas were bulked in a mechanically rotated drum, the same machine being also used for the blending of different grades.

Scant attention appears to be paid to the packing of tea judging from some chests opened in our presence in a packing factory. All of them without exception were not completely filled.

The chests were of the normal size and were made of plywood from local timber.

An interesting feature was the absence of bins, the graded tea being kept in linen sacks prior to packing.

Marketing

Two packing factories were visited, one in Moscow and the other in Tbilisi, the capital of Georgia. The layout of machinery and the machines used were in no way different from similar concerns in the U.K. Much time was spent in both places, and interesting features were:

(1) A chest elevator which tips the contents of the chest into hoppers.

(2) A conveyer belt, the motion of which could be reversed by a simple manipulation of a handle.

(3) A device for transferring tea from a conveyer belt at any point of its travel.

Tea is marketed in small packets in sizes of 50 gms. and 100 gms. roughly 2 and 4 ounces by weight. These are in the form of cartons lined with aluminium foil and paper and quite attractive in appearance.

Teas are re-graded and blended according to a formula, which is varied from time to time according to seasonal changes or variations in quality. Special gift teas in fancy tins are also on sale. The blends turned out can be classified into six main grades, namely:

(1)	Bouquet	(F.B.O.P.)
(2)	Superior	(B.O.P.)
(3)	Extra	(probably F.B.O.P.F.)
(4)	First Class	(probably B.O.P.F.)
(5)	Second Class	Inferior B.O.Ps. and Fannings
(6)	Lowest Class	

There are 10 packing factories in the U.S.S.R., the largest and most modern being situated in Tbilisi. Its annual output is 2,000 tons of green tea and 4,000 tons of black tea. The former goes to the Republics in Central Asia, mostly in the form of brick tea for easy transportation. Dusts from black tea and sometimes fannings are also pressed into bricks. From all the refuse tea caffeine is extracted.

Research

The first institute visited was the All Union Research Institute of Tea and Sub-Tropical Crops. It was founded in 1930 and has four branches, situated in various areas, of which only Chakwa was visited by the delegation where the principal research was plant breeding.

The main station and other centres each have separate laboratories and experimental areas which deal with the following subjects:—

(i) Agricultural practices.
(ii) Fertilizers.
(iii) Soil Science.
(iv) Plant protection.
(v) Ecology.
(vi) Breeding of Citrus.
(vii) Economical aspects of planting.
(viii) Physiological aspects of planting.
(ix) Radio-activity.
(x) Micro-biology.
(xi) Machinery.
(xii) Climatology.

The technical staff at the main station number 90, nearly half of whom possess high academic qualifications. A certain amount of advisory work is carried out but there are no special officers for this purpose. The Director of the station is assisted by two deputies, one scientific and the other administrative. A Board of Control deals with the general policy of the Institute. This comprises 26 members, some of whom are the leading representatives of the industries concerned and others eminent scientists.

The main and sub-stations have in all some 300 acres devoted to field experiments.

The Institute has its printing press and publishes a bulletin every 4 months in Russian and Georgian with summaries in English.

Research is confined to the culture of tea up to the time of its manufacture. Thereafter further research is carried out by the Tea Industry Institute of Technology which was set up in 1953 and concentrates on:

(*a*) Biochemistry.
(*b*) Technology.
(*c*) Mechanization.
(*d*) Economics.

Here again the size of the staff struck us as being large consisting, as it did, of 29 scientists and 60 technical officers besides a team of Tea Tasters.

It was particularly interesting to note that each process of manufacture was in charge of a separate Technologist, who had the use of a special experimental factory nearly as large as that on St. Coombs, fully equipped with experimental machinery and commercial plant. Besides these investigations, chemical means of assessing quality are under study. Chromotographic methods are also being employed for the identification of different elements, and analyses are being carried out on tea polyphenol fractions. In addition to technology and biochemistry, attention is being paid to the economics of tea manufacture, automization and improvements to tea machinery.

It seemed to us that practically every aspect of tea manufacture was under investigation, judging from the problems being tackled. For example:

(i) Manufacturing properties of different varieties.
(ii) Complete mechanization of a tea factory. We were told that in the manufacture of green tea this had already been achieved, but a difficulty in the case of black tea manufacture was the fermentation process.

In this connection, one interesting unit consisting of 4 rollers, all operated on the same cranks but so connected that when one is over-filled, the surplus is discharged from the top of the next roller, and so long as leaf is being charged into the

first roller there will be a continuous feed from one to the other until the leaf is finally discharged from the fourth roller.

Of further interest was a roller with a plastic jacket which enabled the rolling process to be watched.

Another interesting machine was a green leaf sorter which is the natural complement of the mechanical plucking machine.

The principle of separation is on the basis of weight and is effected by moving air being drawn through the leaf which travels on a wire tray. This separates the light from the heavy leaf. This, we understand is on a similar principle to that used for cleaning cotton. The machine has a capacity of 1,200 lb. per hour and is still in the experimental stage.

Breeding (Chakwa Research Station)

This work was commenced about 1926, and is probably more advanced than in any of the other tea growing countries. It has been established here that plants resulting from self-pollination were inferior to those from cross-pollination. It is also maintained that the vigorous qualities shown by cultivated tea are due to their hybrid nature. Accordingly, in the breeding work at Chakwa every effort is made to maintain this so-called "hybrid vigour" instead of attempting to breed pure lines.

Special emphasis has been paid to frost resistance and 3 varieties have been created that are suitable for planting in the Northern regions.

The procedure adopted in the selection work at the breeding station is as follows:—

(1) **Yield.**— Promising bushes are marked out for observation and individual records maintained.

(2) **Quality.**— Leaf from each individual bush is chemically analysed for its polyphenol content but the final selection is made on the basis of taster's opinion. Pubescence of the bud is thought to be an index of quality but the Research Institute has so far not obtained a correlation between hairiness and quality.

(3) **Frost Resistance.**— For obtaining this feature bushes are selected on the following characteristics:—

(*a*) Those that have a tendency to produce red or woody shoots.
(*b*) Flat leaf types and not V shaped jats.
(*c*) Dark leaf jats.
(*d*) In regard to displacement or position of leaves on branches, oblique types rather than horizontal.

The selected bushes are allowed to grow as seed bearers. When seeds are formed they are collected and grouped or classified according to morphological features of the flowers and leaves of the parent bearers. Each group or form is grown in a separate row, and at flowering the bearers are hand-pollinated with pollen of the same group. Some lines were back crossed on two occasions. The pollen is collected in parchment bags in the afternoon and is spread out on newspapers in a verandah and left for 18 to 24 hours for the purpose of partially drying. The dried pollen is then used for pollinating the bearers.

Each generation is examined closely, only those strains that display most of the desired characteristics being kept for further testing. As much as 80% of the hybrids are discarded in the first generation and about 20% discarded in each subsequent generation. Four such generations have passed a very close scrutiny by a number of commissions and 7 lines have been eventually selected. These produce plants that are expected to yield about 30 to 40% more than commercial seed. The progeny of 3 lines have proved to be frost resistant and can be grown in regions where the minimum temperature during winter is 14°F. No large areas have, as yet, been planted with these approved lines.

Vegetative Propagation

Vegetative Propagation was started about 1928. The results obtained have been of a high order, in that the success in the nursery is about 70% and almost 100% in the field. The yields of the better clones are higher than that of unselected seedlings. In the first year, however, the yields of the seedlings are superior to that of clones. This is probably due to the system of planting 4–6 seeds per hole. In their V.P. experiments the following results have been obtained :

(a) Half leaf cuttings give better results than full leaf cuttings.
(b) Brown wood cuttings are superior to green wood.
(c) Brown wood cuttings with 4 leaves are superior to cuttings with 3 leaves, 2 leaves or single leaf.
(d) All types of layering gave a high percentage of rooted plants.
(e) Budding and grafting were not successful.

Labour and Housing

As already mentioned state farms contribute 12% of the total tea production, and the remainder comes from collective farms.

The following are brief descriptions of both.

Laitursky State Farm

This was founded in 1930 and has a total acreage of 5,375 acres of which 2,414 acres are under tea and the balance in citrus, tung and grapes. Of the area under tea 312 acres were newly planted in 1955 and was said to be coming into bearing. The yield in 1946 was 778 lb. per acre and in 1957 was just under the 1000 lb. per acre mark. The farm is worked as 12 divisions. The administration consists of a Director, Assistant Director with an Agronomist in charge of each division.

The total population comprises 5,500 souls of which 1,700 are workers.

Work is done in gangs or brigades ranging in size from 15–35 workers, each in charge of a trained supervisor or Brigadier.

The plucking task varies from 10–16 Kilos per day and incentive payments are paid on a collective basis.

Labour is housed in little wooden 2-roomed houses raised off the ground and, being owned by the State, the workers are charged rent.

Education is provided by 2 Trade and 1 Technical schools. Basic requirements are supplied by a State Shop, and the amenities included a Club House providing occasional cinema shows. 70% of the families were said to possess cattle, chickens and pigs, and all had small garden plots.

The green leaf is sold to the State Factory which is under a completely different organisation. This inevitably leads to friction between Farm and Factory and frequently drastic reductions are made by the Factory on account of poor quality leaf.

Notanebi Stalin Collective Farm

This farm was first organised in 1930 when 427 families worked 3,750 acres. By 1958 this had grown to 10,900 acres supporting 1,056 families comprising 3,247 souls. The tea area was less than 10% being only 865 acres. The balance areas were in citrus, tung, vegetables and arable land.

The Farm is run by a Chairman assisted by an Assistant Manager and 8 members elected every 2 years by the residents.

This forms an Executive Committee responsible to a general council who meet once in 4 months.

The Executive Committee meets once a fortnight and decides the general policy of the Farm. There are in addition 5 State paid Agronomists who act as agricultural advisers.

The income which is derived from the sale of produce is allocated annually as follows:—

20% to a Personal Fund
8% tax
5% cash } to reserve
15% grain }
2% to welfare
50% to an undivided fund which subsidizes the general maintenance of the Farm and purchase of new machinery.

Houses are owned by the individual collective farmers. These are made mostly of timber, are 2 storied and average from 2–4 rooms. The majority enjoy electric light, water is obtained from wells, but the sanitation is of the most primitive type.

There are 1,100 workers divided into 25 Brigades.

The State fixes the production of tea, whilst the target figure for the other crops is decided by the Executive Council.

Like the State Farms there were State controlled shops as well as medical and postal services. It was interesting to note that for a population of over 3,000 there were only 55 pensioners drawing a pension equivalent to 25% of the monthly basic wage.

Kalinin Collective Farm

In 1958, 160 families with a potential working population of 700 labourers, were farming 550 acres comprising 125 acres tea with subsidiary crops of citrus, tung, bamboo and pasture. We were informed that this is one of the most fertile and therefore the most prosperous collective farms in the Republic and the yield of tea in 1957 was 1,200 lb. made tea per acre.

The organization was similar to that of the Notanebi Collective Farm, but as the gross income was considerably greater *per capita,* the basic wage was more than double that on either the State or the collective farms which we visited and no less than 64% of the total income was distributed to the farmers.

Economics

It was extremely difficult to accurately assess the cost of production due to the methods of accounting which are so totally different to those obtaining in Ceylon. However, the cost of packets of tea purchased by members of the delegation in the shops and converted to the rupee equivalent at the normal rate of exchange, revealed the retail cost to be between Rs. 55/- and Rs. 60/- per pound.

Conclusion

Whilst we were impressed by the scale of Scientific Research which is applied to the tea industry in Georgia, we are of the opinion that the general standard of efficiency of tea plantations in Ceylon is in no way inferior to that in Russia, where it is a relatively recent development.

We would tender our grateful thanks to all those who made our visit so pleasant, and we would particularly like to mention the names of H.E. the Ceylon Ambassador to Russia and Mrs. Malalasekera, and Messrs. Mendis and Fernando of the Embassy Staff. To our Russian hosts we would offer our keen appreciation and thanks, especially to Mr. Fonin and Madame Ivanova of the Ministry of Agriculture, and last but not least to our most efficient interpreter Lydia Koneva.

B. Mahadeva
F. Amarasuriya
W. H. W. Coultas
N. M. Sanders
E. L. Keegel
F. H. Kehl

GENERAL PRINCIPLES OF SOIL CULTIVATION AND OF METHODS OF MANURE APPLICATION TO TEA

J. A. H. Tolhurst

In recent years the Institute has done much to encourage lighter systems of soil cultivation than were previously adopted on the tea soils, and the position at present is that many conflicting views exist on the desirable type of cultivation, or even the need for any such operation at all. A common attitude towards cultivation is that it is an essential part of the combined operation of manure application, and in view of the probability of increasing frequency of manuring in the higher yielding tea it is very necessary that we should examine the relation between cultivation and manuring, drawing on all available assistance from experiments, theories of soil science, and practical observation in the field.

An economic aspect, inevitably, has to be considered and recently this has become of more importance. We refer to the rapidly increasing desire to broadcast manure, with no cultivation at all, which is a practice that the Institute has not previously recommended. Our reluctance to do so was based on the suspicion that the obvious advantages of broadcasting manure might easily lead people to ignore the possibility of disadvantages, which might not become evident for several years and by which time a fashion could be firmly established. Once a fashion has become accepted it is difficult to effect a change, particularly if that change necessitates an increase in costs. It is often appreciated that the Institute is gravely handicapped by being required to issue general recommendations suitable for all conditions of tea growing in Ceylon without having had sufficient experimentation under those varied conditions. It is not so generally appreciated that we are definitely limited by long term considerations when requested to give approval to this or that modification in a method of husbandry. Short term results may be obvious and attractive; long term effects, particularly where soil conditions are involved, may be less obvious, and in the extreme may even be damaging and costly to repair.

In the subsequent notes we shall attempt to keep this distinction emphasised throughout, and to bring about a revision in the present attitude to the relation between cultivation and manuring.

A. Cultivation

1. **Principles of cultivation.**—There is no difficulty in deciding the basic function of soil cultivation. The aim is to keep the soil surface in a sufficient state of porosity to allow rain water to percolate into the soil instead of running off on the surface. At the same time as this is achieved the soil will be aerated. As far as observations and experiments have so far shown, cultivation should not be considered as an operation essential for the burying of manure. It is our opinion that

the soluble manures will follow the rain water down into the soil quite rapidly enough, and possibly in some circumstances too rapidly, so that there is no need to help this process unduly.

Although Ceylon tea soils appear to have a high natural porosity, the constant trampling to which the inter-row paths are subjected inevitably leads to compaction of the surface. Compaction may extend only to half an inch in depth, but this may be sufficient to impede percolation of rain water and to allow surface run-off to occur under very heavy storms. Compaction by virtue of compression under-foot is readily envisaged. What is not so readily realised is that a layer of fine dust on the surface can also be an important factor in the formation of a surface pan, simply by percolation into the pore spaces of the uppermost layer of soil and there remaining. The effect of treading likewise is purely superficial, and it can be assumed that soil below two or three inches in depth is quite unaffected by either of these processes.

We have attempted to discourage practices leading to the formation of a dust mulch, but it is not possible to eliminate the formation of dust entirely at certain seasons. Implements such as the weed scraper are the worst culprits, and even the three pronged drag hoe, which seemed at one time to be the answer for light cultivation, has been found to be equally damaging where the soil dries to a hard surface. A weeding implement used with a spudding action would be preferable, as it would thereby break the surface pan without producing very much dust. Treading itself is bound to break dry soil into dust, and the only way to prevent this would be to ensure that the soil itself were not trodden upon, namely, by having an effective mulch of organic matter. While a great deal of progress has been made towards this method of protecting the soil surface, it is realised that it will always be impossible to achieve complete protection economically over large areas. In particular, in the early stages of the cycle, once the pruning leaf has decomposed surface protection is most likely to fail to be adequate.

The most effective way in which to remove the ill effect of surface dust and the ubiquitous and inevitable effect of treading, is to incorporate the deteriorated soil into the lower layers where it will come under the influence of roots and microbes and will be aggregated into crumb-like units. A thick surface mulch of organic matter will produce a somewhat similar effect, but less efficiently. In other words, some form of cultivation which can break the soil open to allow a certain mixing of the top inch or two with the lower layers must be considered a necessity for the long term maintenance of healthy soil conditions.

It would be prudent to insert a warning at this point regarding cultivation in newly planted tea, whether this follows old tea, rubber, or virgin forest or grassland. The effect of uprooting previous crops is to loosen the soil very considerably, and the additional operations before planting tend to aggravate this disturbance. Virgin lands rich in readily decomposable organic matter and with surface layers of, usually, soil of good crumb structure and high porosity, while escaping much of the physical disturbance noted above will nevertheless undergo early internal changes which will lead to the formation of still more drainage channels. If these soils are thatched adequately until the newly planted tea is able to provide good branch cover together with vigorous root growth, it may be expected that their original high porosity will be retained for a considerable period, to be measured in years, and that cultivation with a fork may be unnecessary over this period. The necessity for dibbling in manure will be noted below. However, this fact should not lull us into a false sense of security, and a careful watch should be kept to see when the surface soil structure eventually deteriorates to the point when forking is required to allow heavy rains to penetrate without hindrance.

The brief answer to the question of how to achieve the soil rehabilitation aim by cultivation is, with a fork. From that point, however, we are unable to call upon either general scientific principles or upon controlled experiments in Ceylon.

It must be admitted that we suffer very badly from the absence of detailed cultivation experiments under the very varied soil conditions to be found associated with our tea. By their nature, such experiments would require a long, uninterrupted, life to produce worthwhile results, and extremely precise supervision. There is no lack of ideas on the design of such experiments, but until the organisation is available to carry out the work all our comments on details of cultivation must be based largely on accumulated observations.

We can say, however, that the above arguments hinge on preliminary experiments done by the Agricultural Chemistry Division, and on a very great weight of evidence supplied by similar work in other parts of the world. The general principles of soil science are widely applicable.

2. **Methods of cultivation in mature tea.** (i) DEEP AND LIGHT FORKING.— It would seem to be a justifiable assumption that the only effective cultivation which could provide sufficient mixing of soil layers, subject to the strict limitations imposed by the risk of damage to the tea roots, is the operation known as "deep forking." Although a well known operation, it would be advisable to state what we understand it to imply.

The tines of the fork are inserted to a depth of 12 to 18 inches, ideally, and the fork is then levered forwards. In practice this means that a block of surface soil is pushed a few inches downhill, leaving a crack behind it the width of which decreases rapidly with increasing depth. If the fork tines penetrate to 18 inches, it is most unlikely that the soil will be cracked below a depth of say, 9 inches.

The main effect at lower depths will result from the holes left by the tines themselves. Nearer the surface, of course, the shattering effect of the movement of the fork is considerable, and the soil in front of the fork usually comes to rest with a surface at a greater slope than it had originally. This slope, together with the shattering, and aided by the fact that the labourer usually treads on each freshly moved block when he inserts the fork for the next operation, means that some surface soil is immediately pushed into the deepest cracks available. After a very few showers of rain the cracks will no longer be visible and will not allow further admixture of soil layers. The filled cracks will, however, still provide excellent channels for the ready penetration of rain water, and the period over which this effect remains appreciable will depend on the soil type. Envelope forking of organic material will doubtless extend this period, but it is doubtful whether the organic residues would be of more value underground, rather than left on the surface to protect the newly disturbed soil. We incline towards the latter opinion, as we are here more concerned with the effect of organic matter on soil structure than with its relation to nutrient supply.

Experience in some districts has shown that deep forking when done in both rows together, and also in dry weather, can damage the tea bush. There are conflicting opinions on this point, as might be expected when considering the diversity of other factors involved. For the sake of prudence we continue to recommend that deep forking is done in alternate rows, and for ease of working, that this operation is done early in the pruning cycle in two stages. If deep forking can be combined with a manure application this may not be disadvantageous, as will be discussed later, but the main consideration in deciding the timing should be the suitability of the weather.

We are of the opinion that light forking, to a depth of 3 or 4 inches, with the fork preferably levered backwards, has little effectiveness in mixing soil layers, and that its main value lies in breaking a surface pan with only a small production of dust, thereby allowing free penetration of rain. It thus covers only one function of deep forking. Bearing this distinction in mind it may be said that deep forking represents an attempt to ensure long term retention of good soil conditions, while light forking should be regarded mainly as a short term palliative measure.

(ii) SCUFFLING— This unfortunate word was originally introduced to denote a type of soil disturbance common in European arable farming, and which is often referred to by the above term. It implies a type of shallow ploughing, to a depth of 2 to 4 inches, and can be very effective in mixing manure and soil. It was hoped that a small hand cultivator could achieve a similar purpose in Ceylon tea, but it is now all too apparent that good workmanship is not easy to obtain. Certain hard surfaced soils may sometimes be blamed for this, but probably more important is the ease with which a small cultivator can be scratched along the surface, giving the appearance of a job properly done. In fact, a more normal definition of the word "scuffling" is likely to be suggested, namely, pushing a layer of dust about. If this is to be the end and result of such "ultra-light" cultivation, then we have no more use for the practice than we have ever had for weeding scrapers, and more harm than good will probably follow. It is known that under some conditions the small cultivator, or drag hoe, can give good results when a chopping action is used, as opposed to scraping. As will be shown later, it seems probable that under these conditions even this light cultivation will not be required to accompany a manure application, and it certainly has no other value. Where soil conditions are such that the surface dries hard but readily scrapes to a dust, we suggest that a fork is the only implement to restore reasonable conditions.

We therefore propose to omit consideration of the small cultivator or drag hoe, and to reserve the term "cultivation" for an operation involving the use of the normal large fork, regardless of the length or type of the tines, provided that they are in the same plane as the haft.

3. **Cultivation in Young Tea.**— DIBBLING. This word is occasionally used in connection with manure application to young plants, and as we intend to encourage the practice of the operation which it implies it will be as well to give a precise definition to avoid any confusion, such as has arisen over the term scuffling. Dibbling involves poking a narrow rod straight into the soil and pulling it out with the minimum of leverage.

Various implements can be used, for example, a straight bladed weed spudder, a very small hand fork, or, and probably the most efficient and most popular, a straight pointed stick. The last is the safest type to use round very small plants, and the first is probably the easiest for larger plants where some cutting of roots is less harmful.

The effect is perhaps similar to that of deep forking on a miniature scale, since the action described above permits a fair degree of mixture of soil layers, and leaves long lasting drainage channels without unduly disturbing the roots. In relation to the size of the root system of very young tea plants, this operation may seem to allow manure to be placed deeply. For physiological reasons the Institute has always urged the adoption of the principle of "little and often" for the manuring of young plants, and if this is followed then it should be possible for a young plant to utilise manurial doses which have been dibbled in before they are washed below the reach of the roots. Again, while a mature tea bush may be able to cope with localised high concentrations of manure, a young tea plant seems to be in danger unless the manure is mixed with a large volume of soil without delay. Obviously, weather conditions play a large part in deciding the timing of this operation.

It will be noticed that whereas consideration of the two types of cultivation, namely, deep and light forking, paid little attention to manure application, the discussion on dibbling has emphasised that it is an essential part of manure application to young tea. Dibbling can not really be referred to as a general method of soil cultivation, although its consideration has had to be included in this section for convenience.

B. Manure Application

1. **Principles of Manure Application.**— An attempt having been made to give the reasons for various types of soil management, the same must now be done for the methods of manure application. It can be said at once that this subject is of far greater complexity than that concerning cultivation, and that the experiments so far conducted afford no more than the beginnings of the accumulation of fundamental knowledge of soil chemistry and plant nutrition as pertinent to our particular interests, namely, the efficient utilisation of manure by the tea bush. In the following notes, full use will be made of results from experiments completed or in progress, and rather than having to repeat qualifying statements it will suffice to say at this stage that the ultimate fate of applied manure will be so dependent on detailed variations in soil conditions and bush physiology that any advice on application must be in the nature of a suggestion until a far greater volume of experimental data is available. It is proposed to commence a series of reports on some of the experiments, which will be given in subsequent *Tea Quarterlies*, and if modifications to the present suggestions seem to be called for at any time, they will be inserted in the appropriate report.

2. **Reaction of Manure with soil.**— Living as we do in an age where even the simplest phenomena can be shown to be explicable in terms of complex electromagnetics, it may not occasion surprise to learn that the behaviour of the soil system, manurial compounds, and even the absorbing surface of plant roots are all governed by similar rules. The formulation of these rules is a matter for scientists, but the ultimate object is intensely practical, namely, the forecasting of the necessity for specific manuring to meet specific requirements of the crop plant. The achievement of this object is still a long way off.

Once manure enters the soil it is no longer correct to think about it as though it remained an entity, although from sheer necessity of simplicity of expression we have to continue to speak of the fate of "manure" in the soil. In fact the manurial constituents separate into two groups with opposing electromagnetic properties. Ammonium, potassium, calcium and magnesium belong to the positive group while phosphate, sulphate, chloride (muriate) and nitrate belong to the negative group. It will be seen that what we so commonly refer to as "nitrogen" is in fact represented in both groups, and the conversion of ammonium to nitrate is merely one of the many processes complicating our studies. All the eight constituents named above are in regular use on tea estates; most are essential nutrients for the tea bush, and all require to be considered when deciding how best to apply manure.

Unfortunately, this consideration is bedevilled by the fact that they react with the soil in different ways, quite apart from what could be anticipated from the distinction into positive and negative groups. Some are more soluble in rainwater than others. Some in each group are held by the soil more firmly than others, and may even displace certain other constituents into the drainage waters. Soil pH affects such reactions, and may itself be affected by some of the constituents. Soil itself contains several different types of minerals in the clay and silt fractions which have their own types of reaction with manurial constituents, and in addition organic matter, humus, can play an important part in deciding what the final balance of nutrients will be. Even this is but one stage in the whole process of utilisation of manure, since the individual constituents interact with plant roots in ways which may have little relation to their interaction with the soil complex.

The scientist has two main methods of trying to disentangle these interwoven reactions. Soil can be treated by solutions of chemicals and an estimate made of the quantities of manurial constituents removed. A variety of chemicals can be used, and in various ways, and will extract different amounts of the same constituent.

Sometimes this difference in the estimated soil concentration of a certain manurial constituent is slight, but sometimes it may be surprisingly great. It is for such reasons that soil analysis alone has little value in this context, and requires to be supplemented by chemical analysis of representative parts of the crop plant itself, together with a practical estimate of the ultimate effect of the chemical reactions, that is, the recording of actual crop yields.

The above is a greatly simplified picture of the problems facing the scientist, and which must be overcome before practical recommendations can be put forward on a firm foundation. Soil and plant analysis must be linked together, and the information thus gained must be correlated with yield records. If this is not done, then the effect of unco-ordinated experiments will be to produce data relating to specific conditions and lacking the applicability to general practice which should be the aim of our research. The following suggestions must be read in this light, and on the understanding that co-ordinated experimentation is being done to provide additions and corrections in the future.

3. **Notes on Practical Aspects of Manure Application.**— (i) RELATION TO WEATHER CONDITIONS. Very dry soil can be expected to have little or no reaction with manure, which if broadcast will remain unchanged on the soil surface. If the manure could be placed below the surface of a soil which was still just moist enough to prevent wilting of the tea, it is highly probable that the bush would absorb some nutrients. It is also probable that chemical fixation of manurial constituents by the soil would proceed with little hindrance, and in some soils this process might be of greater effect than root absorption with an ultimate decrease in the efficiency of uptake of the manure. It is not suggested that deep cultivation would be contemplated in the middle of a prolonged drought, but if done immediately prior to the start of a drought and combined with manuring a similar situation could soon arise.

The nitrogen and potash components of the mixture are readily soluble in water and will be dissolved by very little rain. If the first rain after manuring were to run off on the soil surface, an appreciable proportion of the dissolved nutrients would follow the wash into the drains. If, as happens in the great majority of rainstorms, the rainwater penetrates the soil, the dissolved nutrients will also be carried below the surface. Some will react rapidly with both soil and roots, in the upper layers, while others may be carried to greater depths. It is the presence of these problems which makes it impossible to dispense with very detailed chemical analyses to decide what effect certain quantities of rain will have on manure applied on different soil types. It would be prudent to avoid manuring just before or during the most continuous rains of the year, particularly as the activity of the roots in absorbing manure may be suspected to be low in prolonged wet weather in many districts.

If the extremes of climate are to be avoided, then the optimum seasons for manuring when rainfall is moderate and bush activity high, may be all too short to allow manuring and other estate operations to be done just when desired. We suggest that manure could safely be broadcast late in a drought, provided that it is not anticipated that the first rains will run off on the surface. If this practice is followed, the rate of working will be high in the dry weather and with no diversion of labour to either cultivation or to "scratching." With the doses of manure which are at present favoured and with tea of reasonable vigour, the risk of manure scorch from broadcasting would seem to be negligible. Again, this practice would help to bring manuring as far as possible in advance of seasons of "rush crops," and it would take full advantage of an isolated shower of rain before the drought could really be said to have been broken.

It is suggested that the oldest fields, giving the greatest soil cover, are manured first in this scheme, if all fields can be dealt with in time, but if some manuring has

to be delayed into early monsoon weather then it would be preferable to carry forward the oldest fields. Young fields should take priority when adjusting the manuring programme to weather conditions, partly because the soil protection afforded is not great and partly because it is suspected that the root systems may have a lower storage capacity for nutrients than would be expected in older tea.

If it is necessary to fork the soil to prevent run off of rain, then manuring will have to be delayed until the cultivation can be safely done. If it is desired to fork in any event, regardless of risks of run off, there is no reason to object to broadcasting manure in dry weather, followed by forking several weeks later, since the cultivation in this instance has little bearing on the efficiency of manure uptake, and the two operations should be considered separately.

A fear is sometimes expressed that manure will be "lost" if it remains on the soil surface for more than a few days. This is not so. The two soluble components of the standard mixtures are capable of dissolving on a moist soil surface, within two days, even with no rain falling, and when generous doses are applied. Once dissolved in the topmost layer of soil the nutrients will remain there until washed downwards by succeeding rain. Occasionally the smell of ammonia can be detected in the manure shed, or in the field, especially if the bags become damp. Ammonia can be detected in minute quantities, and the slight odours referred to represent negligible amounts of nitrogen. No labour force could be induced to handle manure which was evolving appreciable quantities of ammonia. The residue of manure seen on the soil surface after a little rain consists of saphosphosphate, from the standard mixtures, and of course dolomite would behave in the same way as both manures are only slowly soluble.

(ii) Frequency of application, size of dose, and distribution. While we have no hesitation in recommending frequent small doses of manure to rapidly growing young plants, to the extent of three or four applications per annum, we are more limited in our ability to make the same suggestions for mature tea. It is so improbable that any soil or mature tea bush could store a year's supply of nutrients and release them steadily that we have equally no hesitation in referring to a frequency of manuring of twice per annum as being the minimum, regardless of the quantity of manure involved.

In the North-East monsoon districts, with a prolonged resting period and drought, it is probably not yet necessary to consider increasing this frequency of application, even if it were practicable to do so. However, when we eventually have to consider fields in the 2,000 to 3,000 pounds per acre per annum category, we may have to reconsider this question, but at present we do not know what capacity a very high yielding bush has to store nutrients over the shorter cropping season in such climatic zones.

Where weather conditions permit, it might be desirable to split annual manure doses in excess of say 120 pounds of nitrogen per acre, into three applications. Only extensive experiments can decide whether the increase in costs will be compensated by increased yield. Where broadcasting is adopted, more frequent application of manure, which can be timed to suit weather conditions, may be a more attractive proposition. Individual doses can, of course, be adjusted so that a greater proportion of the annual allocation can be put out at a particular season, for example to build up bush reserves prior to a "quality season."

It is quite impossible to say what is the optimum individual dose of manure, from the viewpoint of efficiency of utilisation, but if the above tentative figure of 120 pounds of nitrogen (manure equivalent) is accepted as the division between two and three applications a year, it is unlikely that the variations in the efficiency of the individual doses thus brought about will have an appreciable effect in practice. Further, a healthy tea bush is not easily damaged by even heavy applications of manure unless distribution is extremely irregular. Wherever practicable we suggest

that manure is distributed in both rows, because although it is known that a tea bush can obtain manure which has been applied at a little distance, it seems prudent to make distribution as uniform as possible to allow the greatest possible number of roots to absorb the nutrients before they are washed out from the soil or chemically fixed. Nor should we forget the impossibility of obtaining uniform distribution in practice. Unmanured strips in one row should on average be compensated by manure in either or both of the adjacent rows. We are, also, opposed to the various types of placement of manure, such as inclusion in envelope forking, which we consider to be too liable to abuse, and likely to waste the potentialities of the widespread fibrous root system of the tea bush. There would seem to be no necessity to try to distribute manure up to the bush centres themselves or into the spaces between the bushes in each planting row, as the difficulty of this operation would certainly lead to poor workmanship and possibly damage to the bark. In practice about two-thirds of the soil area in the inter-row path receives the manure when no attempt is made to govern distribution by certain types of cultivation, and we believe that this allows the most active tea roots to make the best use of the manure.

A qualification is required for manuring young plants. Here, as has often been stated, manure should be applied in a band round each plant, so that the manured zone lies under or just outside the spread of the branches. The width of the band should also increase as the plants increase in size, until eventually the mature tea type of distribution is necessitated. It is recommended that the utmost care be taken to keep manure from touching the bark, and also to avoid localised concentrations of manure because young plants very soon show the effects of excess manure. Manuring young tea requires closer supervision than for mature tea.

(iii) Relation to Pruning. It has become increasingly evident that generous manuring close to pruning, before and after, is repaid by more vigorous recovery. In the shorter cycles where recovery is very rapid, it may be desirable to ignore the pruning gap when fixing the times of manure application, since the bush can never be said to be dormant over this period. In the longer cycles manuring may be timed to take into account a short period after pruning when the growth rate of the bush is obviously very slow, but it should be remembered that the bush late in a cycle can take up and store nutrients which will most probably assist bud break after pruning. The last manure application in a cycle of four years or longer could very well be made at not more than six months from pruning, depending always on weather conditions. If an economy in application should ever be required, we suggest that the first and last applications in a long cycle should remain intact in quantity and in timing. In a short cycle it may be that the manuring after pruning is of most importance, and that economies could be distributed over the remaining applications, including the last one.

In a very short pruning cycle, two years or less, there may be no necessity or justification for reducing the size of the manure application following pruning. However, in longer cycles a reduction in this application would usually seem to be called for. Once the buds have developed into discernible shoots it may be supposed that the bush is capable of absorbing manurial nutrients without much difficulty and with advantage. If manuring were desired at this very early stage, for the highest yielding and most rapidly growing tea for example, we suggest that a dose one-quarter of the annual average dose for the previous cycle be applied. If application were to be delayed until nearer tipping, this dose could be increased to one-third or even one-half. This presupposes that a normal cropping cycle has preceded pruning to give a guide to the annual manurial requirements. If cropping capacity appears not to have reached the maximum it would be good policy to base the size of the doses on an anticipated increase in yield and to make the applications as early as possible. This would thereby allow for errors of underestimating to be made up in the succeeding annual allocation of manure, without having deprived rapidly growing shoots at the critical stages after tipping.

It must be emphasised that the very early manuring referred to should preferably be associated with two other applications within about one year from pruning, weather permitting, since the object of this exceptional manuring would be to assist rapidly developing bushes. Where the first application is made at tipping, subsequent manuring within the year could be made in one or two doses according to the vigour of the tea.

Where normal mature tea is under consideration, with a known economic maximum cropping capacity and a known response to a "maintenance ratio" of manuring, it would seem reasonable to fix the first manure application at about one-third of the annual average dose for the previous cycle. It would not seem to be wise to talk in terms of "×" pounds of manure as "the tipping dose." Nutrient requirements by tipping growth can be expected to bear a relation to cropping potential, and it is well known by now that crop has a close connection with manure application.

In general, this extremely complex aspect of the allocation of manurial doses, can be expressed in the familiar phrase "little and often." The more probable it is that a long cycle field is capable of expanding its yield, the more frequently it should be manured early in the cycle, with no temptation to reduce the size of the doses simply because the bush is producing tipping growth and not "crop."

At the other end of a long cycle, assuming always that the last manure application remains close to pruning as mentioned earlier, we might take advantage of a well developed frame and root system by suggesting that the more vigorous the tea the less need there would be to consider splitting the manure allocations into frequent doses. In a three or four year cycle two applications in the final year would seem to be ample, under such circumstances, while in longer cycles the applications might be reduced to three in two years. It will be realised that the tendency of these suggestions is to distribute the manure allocation for the whole cycle over smaller and more frequent doses earlier in the cycle at the expense of distribution late in the cycle. This has a secondary advantage in that the labour can achieve greater efficiency of distribution in the younger tea. Even where it is not possible to forecast the manurial requirements for the whole cycle in tea of expanding cropping capacity, it is still practicable to work to the above scheme, and indeed this seems to be the only safe way in which such requirements can be worked out without running the risk of starving the bushes in the early part of the cycle, or else of going to the other extreme of excessive manuring.

(iv) Depth in Relation to Distribution of Manure. As has been hinted earlier in these notes, consideration of the optimum depth in the soil at which manurial constituents should be, for the greatest benefit of the tea bush, is so beset by a host of interacting factors that an answer can only be hazarded. When research has produced more evidence than at present, it will no doubt be found that different answers are given for different climatic conditions.

It would seem that the two soluble manures, containing nitrogen and potassium, are readily washed into the top few inches of soil from broadcast applications, and it is reasonable to suppose that they thereby come into contact with the greatest concentration of active tea roots. The two slowly soluble manures, saphosphosphate and dolomite, will not penetrate to the lower depths in their natural state unless cultivation provides assistance. When they dissolve and release their component nutrients, these may behave in the same manner as the two soluble manures, with the exception that the released phosphate ion is very active chemically and probably reacts with the soil to form yet other insoluble compounds. For this reason the operation of deep forking seems to offer a useful means of guarding against a concentration of some nutrients in the surface layer of soil. The slowly soluble manures here mentioned may be considered as long term manures, and there is no reason to suggest more frequent deep forking simply to mix them with the lower soil layers.

The suggestions given in the section on cultivation may be taken as adequate for this purpose.

Deep forking, by loosening the surface soil and roots, may encourage greater root activity at lower depths for a short while, and since manure or manure rich surface soil will tend to be moved into lower layers it will be appreciated that the efficiency of uptake of manure should not be impaired, unless forking has been very vigorous and rainfall immediately following is very intense. Under these latter conditions there would seem to be a real danger of some manurial constituents, for example nitrogen and potassium, being washed below the reach of most of the fibrous roots.

(v) Relation to Organic Residues. While we should not forget that humus, namely, the appreciably decomposed organic matter which is in intimate association with the mineral fraction of the soil, plays an important and beneficial part in regulating the efficiency of manuring, it is intended to restrict our consideration here to various bulky organic materials which may affect the actual application of manure.

Weeds can conveniently be grouped with the residues, because the growing weed eventually becomes such, either by natural death or as a result of weeding operations. If weeds remain in the field when they die, the nutrients which they have absorbed will be returned to the soil slowly. The residue will, in fact, be equivalent to compost and its effect will be beneficial. If, however, the weeds are removed from the field there will be a corresponding loss of nutrients. This fact must be taken into account when timing weeding and manuring. Weeds removed within a few weeks after manuring would certainly carry an appreciable portion of the manure with them. A vigorous growth of small weeds, for example Oxalis, annual chrysanthemum or Drymaria, may suffer scorching if manure falls on the leaves while they are wet, and the dead foliage can be considered as a useful manure in itself. If no such scorching occurs and if the weed growth has been deliberately allowed to flourish, as a soil protection, then there may be a temporary shortage of available manure for the tea. On a long term consideration that is not important, but if it is desired to obtain the quickest possible reaction to the manure application a dense growth of weeds, or for that matter small cover crops, should be chopped down before manuring.

Dead weeds, fallen tea leaves, shade tree loppings and grass thatch will all absorb some manure if this is spread on top of the residues. The amount retained is not great, unless the quantity of organic residue is very considerable. Such a situation may arise where young tea plantings are heavily thatched, but a temporary shortage of manure should not arise if it is distributed on the soil round the young plants as recommended, the thatch being moved if necessary to allow this. It will be repeated that we consider the main value of all these organic residues is to be found in the protection afforded to the soil surface. In addition they will return their mineral nutrients to the soil as they decay, and at the same time they will add to the humus reserves of the soil without the necessity of being buried. They represent a conversion of inorganic fertilisers into organic nutrients, usually at no extra cost, and in this respect they must be considered valuable assets as long as they are not removed from the tea field from which they obtained their nutrients.

Timber from shade trees represents a permanent loss of nutrients from the soil, as does the pruning wood from the tea itself. These unavoidable losses are, of course, allowed for in the rate of manuring adopted for each field, and have no bearing on methods of manure application.

Composts, of various types, and bulky animal residue manures can hardly be said to affect methods of application of the normal inorganic manure. Their own application should make full use of their value as protectors of soil structure, and, therefore, they should be applied in heavy applications of ten to twenty tons per

acre and may be allowed to remain on the surface. Tea after pruning would benefit most from this combined mulch and manure. If, for a special reason, an additional inorganic manure is to be applied, this could be more effectively done before spreading the compost, etc.

Other organic residues are occasionally suggested for use in tea fields, and advice should be sought beforehand, as some may have undesirable properties, and their consideration in a general article would not be justified.

C. Conclusions

1. Distinctions are drawn between the various types of cultivation, emphasising their different effects on soil conditions, both long and short term.
2. It is suggested that cultivation should be practised primarily to maintain good soil conditions.
3. Special cases are noted where a form of soil cultivation is required to accompany manure applications.
4. Attempts are made to give general guidance in the problem of the actual application of manure.
5. Suggestions are given for concentrating manure applications in the earlier years of the longer pruning cycles.
6. Methods of achieving some economy in application of manure are suggested.

THE EFFECT OF MARIGOLDS AND SOME OTHER CROPS ON THE *PRATYLENCHUS* AND *MELOIDOGYNE* POPULATIONS IN TEA SOIL

T. Visser and M. K. Vythilingam

1. Introduction

Recent investigations carried out by OOSTENBRINK *et al* (6) and MEYNEKE *et al* (5) showed that several varieties of *Tagetes erecta* and *T. patula* reduced the population of certain root-infesting nematode species, such as *Pratylenchus*, *Tylenchorchynchus*, *Paratylenchus* and *Rotylenchus*, in the soil, while *Meloidogyne* species are probably also suppressed.

With regard to the effect of the cultivation of Tagetes on the population density of *Pratylenchus* species, a reduction of the order of 90% was normally obtained in comparison with other crops. The roots of the different marigold species and varieties were found to contain fewer *Pratylenchus* eelworms than any other crop tested. The number of eelworms found in the former was about 1% of the average of that for roots of a great number of agricultural crops.

It was also found in one of the experiments, that the eelworm population of a soil cultivated with marigolds was even less than that of a fallow soil fumigated with DD. The effect of marigolds on eelworm appears to be due to the nematocidal action of the growing plant roots, probably due to the exudation of *alpha*-terthienyl. This compound, which is known to be produced by marigolds, has been shown by UHLENBROEK and BYLOO,[1] to have a strong nematocidal action.

The experiments of OOSTENBRINK and his co-workers gave also abundant proof that the cultivation of marigolds, either as a "pre-crop" or as a cover has considerable value for the control of eelworm infestation in crops.

With a view to these promising results it was thought worthwhile to investigate whether *Tagetes* species would have a similar effect on eelworms when grown in Ceylon tea soils. In order to have some standard of comparison we included *Tephrosia vogelii*, *Crotalaria usaramoensis* and *Cr. anagyroides* in our trials, while also the influence of Guatemala grass (*Tripsacum laxum*) was also studied.

2. Experimental results

The effect of the cultivation of marigolds and other plants on meadow eelworm (*Pratylenchus coffeae*[2]) and root-knot eelworm (*Meloidogyne javanica*) was investigated in a number of small scale trials and field experiments carried out at St. Coombs and some other estates.

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[1] *Paper sect. VII, Int. Blant. Prot. Congr. Hamburg* (1957).

[2] *Identification after: Sher, S.A. and M. W. Allen Un. Cal. Publ. Zool.* 57, 1953: 441–470.

With regard to marigolds, we tried out a dwarf form, *T. patula nana flora* (I), which grows approximately to a height of 7–10" and two varieties obtained locally, which grew to a height of about 4–5', determined as *T. patula nana L.* cult. *Nana plena* "Harmony" (II) and *T. erecta L.* cult. *Plena* "Colorado Sunshine" (III). Variety II is characterised by orange flowers having a fringe of dark brown petals; variety III by its light yellow flowers. The former variety is more vigorous, branches more freely, seems to be less susceptible to environmental conditions (rain) and diseases, and has a somewhat darker foliage than the latter variety. It was also found that this variety withstood lopping better than the yellow flowered variety; both grow to a height of 4-5 ft.

Soil sampling was done as follows: from each treatment a number (2–6) of composite samples (each a mixture of 3–7 separate samples) was taken; 100 g of each was used for eelworm assessment according to the Baehrmann technique. The eelworm infestation of the roots was determined by subjecting 10 g samples to a fine spray of water for 7 days according to the method in use at the Nematology section of the Plant Protection Service (P.D.) at Wageningen, Netherlands.

2.1. Small scale trials

I. The first experiment was carried out in pots and consisted of the following treatments: (*a*) fallow, (*b*) *Tephrosia vogelii*, (*c*) *Tagetes patula*—I, (*d*) *T. erecta*—III.

Each treatment was replicated 6 times, the soil of the pots was moderately infested with meadow eelworm and heavily with root-knot eelworm.

TABLE 1.—*Eelworm population per* 100 *g soil* (*avg. of* 6 *samples*) *and per* 10 *g roots* (*avg. of* 2 *samples*) *in pot experiment*

1	2		3		4			5		
	In soil							In roots		
Treatments	26-11-57*		8-3-58		19-5-58			19-5-58		
	Pr	Mel	Pr	Mel	Pr	Mel	Oth	Pr	Mel	Oth
Fallow	10	36	13	1	35	30	910	—	—	—
Tephrosia	28	157	14	56	10	60	1350	1630	5620	14630
T. patula (I)	15	115	15	2	5	0	580	0	0	120
T. erecta (III)	14	80	14	4	0	5	325	0	40	140

*Date experiment started. Pr=*Pratylenchus coffeae*; Mel=*Meloidogyne javanica*; Oth=other eelworms.

It can be deduced from the results presented in table 1 (columns 2, 3, 4) that both species of marigolds notably reduced the *Meloidogyne* and *Pratylenchus* populations when compared with *Tephrosia*. The marigolds were even more effective than keeping the soil fallow. This is also apparent in respect of other eelworms which numbered highest in the pots with *Tephrosia* and lowest in the pots with marigolds. The root tests (column 5) showed even more striking differences, *Tephrosia* roots containing a formidable number of both parasitic and other eelworms. The marigold roots, on the other hand, did not harbour any meadow eelworms, while only a small number of root-knot eelworms were isolated from roots of the *T. erecta* variety. The number of other eelworms was less than 1% of that found in *Tephrosia* roots.

II. The second experiment was done on small plots of 3 × 3 ft. and consisted of the following treatments (in duplicate): (*a*) fallow, (*b*) young tea plants, (*c*) *Tephrosia vogelii*, (*d*) *Crotalaria usaramoensis*, (*e*) *Tagetes patula* (II), *T. erecta* (III). The soil used for the experiment was moderately infested by meadow eelworm and contained only a few root-knot eelworms per sample.

TABLE 2.—*Average soil infestation* (*per* 100 *g*) *and root infestation* (*per* 10*g*) *of different plants*

1	2			3			4			5		
Treatments	In soil									In roots		
	2-6-58			20-9-58			9-12-58			9-12-58		
	Pr	Mel	Oth	Pr	Mel	Oth	Pr	Mel	Oth	Pr	Mel	Oth
Fallow	8	1	320	34	0	375	9	0	220	—	—	—
Tea	7	0	340	10	5	250	253	0	365	5260	0	1380
Tephrosia	15	3	500	35	8	500	45	4	725	480	38	570
Crotalaria	14	3	360	1	0	180	4	0	240	3	0	470
T. patula (II)	13	0	370	11	0	430	1	0	700	2	0	32
T. erecta (III)	9	0	460	7	0	275	3	0	240	3	2	44

N.B.—Experiments started 20th May, 1958; see for abbreviations table 1.

It appears from the data given in table 2 (columns 3, 4, 5) that the meadow eelworm population of the plots planted with young tea very considerably increased in about 6 months and to a lesser extent, in the plots sown with *Tephrosia*. Both *Crotalaria* and marigolds reduced the population. Only the *Tephrosia* plots contained a small number of root-knot eelworms. With regard to the roots (column 5) it can be seen that the tea was very heavily and *Tephrosia* moderately infested with meadow eelworm, the latter also harboured root-knot eelworms. The roots of *Crotalaria* and marigolds, however, contained only a negligible number of meadow eelworms and no root-knot eelworms. It is worthy of note that the number of other eelworms in the marigold roots is very small as compared with the number of those in the other plants.

The data of both trials indicate that the marigolds have to reach maturity—which takes 5 to 6 months—before they are fully effective (compare columns 3 and 4).

2.2. Field Experiments

I. Field experiments on mature tea were laid out on Mount Vernon and Eildon Hall estates in fields known to be infested by meadow eelworm, as was also noticeable from the considerable number of bushes in a drying or poor condition. The soils also had a fairly dense root-knot eelworm population. In both trials tea was retained in one area and uprooted in the other. Each of the respective areas was divided into 4 plots measuring 25 × 25 ft. The following treatments were carried out in both the fallow area and the area with tea (pruned at the start of the experiment):

Mount Vernon—1 plot sown with *T. erecta* (III), 1 plot with *T. patula* (I) and 2 plots with weeds and *Crotalaria usaramoensis*.

Eildon Hall—2 plots with *T. erecta* (II) and 2 plots with weeds.

On both estates the *T. erecta* variety grew exceedingly well in the fallow plots reaching a height of nearly 5 ft. (see Fig. 1) 6 months after sowing. *T. patula* did not grow well in the tea, while the cover given in the fallow plots compared unfavourably with that of *T. erecta*.

The marigolds in the fallow area were sown in rows about 9″ apart; in the pruned tea the seeds were sown between tea rows and in vacant spots. At Mount Vernon estate, *T. erecta* gave an excellent cover in the pruned tea and had become higher than the bushes 6 months after sowing. At Eildon Hall estate growth was satisfactory in the vacancies but not between the tea rows, probably because of the quick recovery of the bushes after pruning causing unfavourable light conditions for the flowers.

Figure 1.—Growth of *T. erecta* 5 months after sowing in fallow tea soil (mature tea in background)

TABLE 3.—*Influence of marigolds and weeds on the eelworm population of tea soil with or without mature tea* (*eelworms*/100 *g soil*)

A. Mount Vernon

Treatments	28-11-57*		26-6-58		3-9-58		
	Pr	Mel	Pr	Mel	Pr	Mel	Oth
Weeds	20	11	0	10	2	10	491
T. patula	14	2	0	13	1	3	296
T. erecta	13	14	1	11	2	3	291
Tea + weeds	23	20	10	76	33	3	361
Tea + *T. patula*	18	20	3	14	19	0	202
Tea + *T. erecta*	20	7	4	7	8	0	246

B. Eildon Hall

Treatments	21-1-58*		19-5-58		21-8-58		
	Pr	Mel	Pr	Mel	Pr	Mel	Oth
Weeds	63	54	3	7	4	17	315
T. erecta	94	62	2	8	1	6	245
Tea + weeds	61	33	7	25	26	21	304
Tea + *T. erecta*	248	15	3	30	10	6	111

*Date experiment started; see for abbreviations table 1.

The results presented in table 3 show that the marigolds in both trials had significantly reduced the *Pratylenchus* and *Meloidogyne* populations and that of other nematodes in the soil both when growing as a pure crop and when sown in tea. The marigolds had a greater repressing effect on eelworms than leaving the soil to weeds. The trial at Mount Vernon estate indicates that *T. erecta* was more effective than *T. patula* probably due to the more vigorous growth of the former.

TABLE 4.—*Root infestation of marigolds and other plants and the effect of these plants when intergrown with tea on the infestation of tea roots*

Location & sampling date	Roots from	Eelworms/10 g roots Pr	Mel	Oth
Eildon Hall 21-8-58	*T. erecta*	0	3	52
	Tea (+ weeds)	77	0	74
	Tea (+ *T. erecta*)	28	0	81
Mount Vernon 19-5-58	*T. erecta* III (2 plots)	10	170	290
	,,	0	0	10
	T. patula	0	0	120
	Weeds:			
	Axonopus compressus	0	0	1177
	Crotalaria anagyroides	20	0	1450
	Sesbania cinarescens	50	50	5560
	Oxalis corymbosis	63	2510	2917
19-5-58	Tea (+ weeds)	620	0	390
	Tea (+ *T. patula*)	0	0	200
	Tea (+ *T. erecta*)	0	0	170
3-9-58	Tea (+ weeds)	210	0	441
	Tea (+ *T. patula*)	115	0	302
	Tea (+ *T. erecta*)	83	1	99

Table 4 presents the root infestation of marigolds, of four species of "weeds" (2 of which are leguminous bush crops) growing in plots without tea, and of tea with or without marigolds 6–10 months after the experiment started. It can be seen that the meadow eelworm infestation of marigolds was nil or negligible, while the roots were only in one instance found to harbour a number of root-knot eelworms. The number of other eelworms was very low when compared with that of the weeds.

and cover crops (*Crotalaria* and *Sesbania*). The grass (*A. compressus*) appeared to be free of parasitic eelworms; *Crotalaria* roots were only lightly infested with meadow eelworm, while *Sesbania* was moderately infested with both meadow and root-knot eelworm. *Oxalis* roots, besides harbouring some meadow eelworms, were heavily infested with a root-knot eelworm which was identified by Dr. Oostenbrink as *M. arenaria.*

With regard to the tea roots, the figures show that those obtained from the areas which had marigolds as a cover crop carried considerably less meadow and other eelworms than those from plots with weeds in all instances.

II. The second experiment was done with a view to ascertaining the effect of marigolds on young tea. The experimental area concerned already carried young tea which badly suffered from meadow eelworm infestation before the experiment started. These plants were uprooted and replaced by one year old plants of clone 2024. The area was divided into 3 plots (7 × 15 yards) with the following treatments: (*a*) fumigation with Shell DD (2 weeks before planting), (*b*) sown with *T. patula* II in rows 9″ apart, (*c*) left fallow. Each plot had 8 rows of 15 plants each; the "fallow" and fumigated plots were clean weeded throughout. Planting was done by the end of June; the marigolds were sown in the beginning of July, 1958 (in plot *b*). As they had fully covered the plot by the end of October and reached a height of about 4 ft., lopping around the tea plants at monthly intervals became necessary. The tea plants were manured twice at the rate of ½ and 1 oz. Sterameal respectively.

The relevant data concerning the eelworm population of the soil, infestation of the roots and average number of leaves and height of plants recorded 5 to 6 months from the start of the experiment, are given in table 5.

TABLE 5.—*Effect of fumigation and sowing of marigolds as a cover crop on the eelworm population of the soil, infestation of the roots and on growth of young tea plants*

1	2			3			4	
Treatments	Eelworms per 100 g soil 3-12-58			Eelworms per 10 g roots 3-12-58			Avg. per plant 19-1-59	
	Pr	Mel	Oth	Pr	Mel	Oth	No. of leaves	Height in ins.
Tea fallow	13	0	240	4385	2	1485	29.1 (100)	15.2 (100)
Tea + *T. erecta*	6	0	250	1315	0	475	34.0 (117)	18.1 (119)
Tea fumigated	1	0	195	780	1	480	57.1 (168)	19.5 (128)

N.B.—Figures within parentheses in column 4 express number of leaves and height in % of control (tea fallow); see for abbreviations table 1.

The above table again indicates that marigolds intergrown with tea both depressed the meadow eelworm population in the soil as well as decreased the degree of infestation of the tea roots. Fumigation had a greater effect. as is also illustrated by the enhanced growth of the plants. The tea plants with the marigold cover crop had also grown somewhat better than the control plants. Their growth was, however, less good than expected on account of the decreased infestation. This is probably partly due to competition and partly due to the fact that the marigolds become effective only after reaching maturity with the result that the tea plants become infested before that stage is reached. The infection of the tea plants in the fumigated soil is probably mainly on account of the too short interval lapsing between fumigation and planting (8).

An assessment carried out in July, 1959, showed a number (average of 6 samples) of 74, 23 and 71 meadow eelworms per soil sample for the fallow, marigold and fumigated plot respectively. Accordingly, one year after the experiment started marigolds appear to have been more effective than fumigation.

III. It appeared from a field experiment reported elsewhere (8), that a meadow eelworm infested area the tea of which had been uprooted and subsequently planted with Guatemala grass (*Tripsacum laxum*), had become practically free of eelworm 8 months later, the period required for an adjacent, but fallow area was 12 months. This finding was in accordance with previous observations (9) and suggested that Guatemala grass is not susceptible to meadow eelworm. However, since this grass is so widely used for soil reconditioning and also in eelworm infested areas, we sought further confirmation as to its resistance.

For this purpose soil and root samples were taken from meadow eelworm infested fields of two estates on which mature tea had been interplanted with Guatemala grass for 1–2 years. The controls were samples obtained from an area of tea without grass and of grass without tea (planted in the vacancies). The results from soil and root sampling (average of 6 composite samples) are recorded in table 6.

TABLE 6.—*Soil and root infestation of tea and Guatemala grass when intergrown and when growing separately*

1	2			3			4			5		
Soil or roots from	Eildon Hall Estate						St. Clair Estate					
	per 100 g soil			per 10 g roots			per 100 g soil			per 10 g roots		
	Pr	Mel	Oth	Pr	Mel	Oth	Pr	Mel	Oth	Pr	Mel	Oth
(*a*) Grass only	3	15	309	31	1	880	2	9	360	1	4	270
(*b*) Grass + tea	16	7	267	39	0	135	20	1	790	4	1	170
(*c*) Tea only	24	1	409	1874	2	1135	24	1	250	1120	3	540
(*d*) Tea + grass*	—	—	—	267	2	365	—	—	—	315	1	265

*The soil samples of (*d*) are the same as those of (*b*); see for abbreviations table 1.

It can be deduced from table 6 (columns 2 and 4) that the Guatemala grass planted in formerly infested plots (*a*) had notably reduced the meadow eelworm populations, while it had little effect on the population when interplanted with tea (*b*) as compared with tea only (*c*). However, it appeared from the root tests (columns 3 and 5) that roots from tea bushes intergrown with the grass (*d*) were very much less infested than tea roots from bushes growing on their own (*c*). The meadow eelworm infestation of the grass roots was low as compared with that of tea roots and virtually the same whether the roots were obtained from grass growing together with or separately from the tea.

3. Conclusions and summary

The experiments leave no doubt that the marigold species tried out, *Tagetes erecta* and *T. patula*, can considerably decrease the *Pratylenchus coffeae* (meadow) and *Meloidogyne javanica* (root-knot) eelworm populations in tea soil. In fact the cultivation of marigolds reduced the populations more quickly and more effectively than keeping the soil fallow. Their roots usually carried no meadow or root-knot

eelworms or relatively small numbers where the soil was heavily infested. Apparently eelworms are able to invade the roots to some extent. This probably occurs before the plants have reached full maturity, as only then the repressing effect on eelworms becomes noticeable. However, it is unlikely that the invading eelworms survive because even the number of non-parasitic eelworms found in the roots was only a fraction of that found in other plants. It also appeared that marigolds as a cover crop both in young and in mature tea notably decreased the infestation of tea roots by meadow eelworm. Our observations on the effect of marigolds on eelworm are in complete accordance with those of Oostenbrink *et al* (6).

Accordingly, marigolds show considerable promise for the control of eelworms in tea soils. Marigold varieties of the "bush type" are preferable to the dwarf forms in respect of height, vigour, production of organic matter, extensiveness and depth of root system and ability to withstand lopping. It is not expected that marigolds can be generally grown as a cover crop in mature tea after pruning unless there are many vacancies, because the period between pruning and recovery is normally not long enough for their establishment. The cultivation of marigolds as a pre-crop or cover crop in young tea is feasible. However, our agricultural experience with this crop is limited and more information is needed.

With respect to *Tephrosia vogelii*, it was observed that this plant is susceptible to both meadow and root-knot eelworm, thereby sustaining or increasing the original populations in the soil. This confirms previous findings of Gadd (1, 2) and Gadd *et al* (3). This bush crop should, therefore, not be planted in any area which is suspected to be infested with meadow or root-knot eelworm.

Crotalaria usaramoensis and *Cr. anagyroides* appear to be largely resistant to meadow and root-knot eelworm attack and depressed the population in the soil. In this connection it is worthy of note that inoculation experiments carried out by Gadd (2) in the past indicated that both species are unsuitable hosts for meadow eelworms. These observations are also substantiated by recent field sampling (Visser—8) which showed that both *Cr. usaramoensis* and *Cr. anagyroides*, though growing in infested soil, were virtually free from parasitic eelworms. Further, Peacock (7) found from inoculation trials that *Cr. striata* and *Cr. retusa* were resistant to *M. incognita var. acrita*, though *Cr. usaramoensis* and *Cr. juncea* appeared to be susceptible to some extent. Macbeth *et al* (4) noted that *Cr. spectabilis* reduced the severity of root-knot eelworm attack on tobacco grown subsequently. The above suggests that non-susceptibility to *Pratylenchus* and *Meloidogyne* infestation may be a general feature of the genus *Crotalaria*. Hence, *Crotalaria* species would seem to be suitable bush crops in eelworm infested areas.

With regard to *Tripsacum laxum* (Guatemala grass), it would appear that this grass is also non-susceptible to meadow and root-knot eelworm attack. It depressed particularly the meadow eelworm population of the soil, while its roots harboured only few parasitic eelworms. When intergrown with tea, it considerably reduced the meadow eelworm infestation of the tea roots. The above corroborates field observations made previously (8, 9). Accordingly, soil reconditioning with this grass, is also recommended on account of its adverse effect on eelworms parasitic to tea. Though reducing the infestation of tea, interplanting is not advisable, because of severe competition for nutrients and water.

The experiments showed that both mature and young tea is very susceptible to *Pratylenchus coffeae*, judging from the very large number of eelworms which may be found in the roots. Mature tea is apparently not susceptible to *Meloidogyne javanica* as was already observed in the past, though root-knot eelworm is dangerous to young plants.

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THE POSSIBILITY OF TIMING BLISTER BLIGHT SPRAYING ACCORDING TO SUNSHINE RECORDS

T. Visser, N. Shanmuganathan, D. Mulder

I. Introduction

The usefulness of a practical system of forecasting blister blight outbreaks on tea has been realised and needs no emphasis. Several investigators during the past six years have suggested methods of forecasting blister blight incidence based on the relation between weather conditions and the outbreak of blister blight.

Till recently no work of this nature has been done in Ceylon. However, the need for a suitable forecasting system had been realised and its usefulness was discussed briefly previously (**1**). Work was, therefore, initiated during the monsoon season of 1958 to devise a suitable system for use on tea estates in Ceylon, a full account of which will be given in papers by Visser (**2**) and Visser *et al* (**3**). A summary of the main results and their practical implications follows below.

2. Material and method

Two systems, one based on the total daily sunshine and another on the amount of spore germination obtained on glass slides in the field, were tried out during the course of the investigations. It was found that the first system appeared more practicable under existing conditions and, therefore, in this paper we will briefly describe this system and discuss its merits.

According to this system, spraying against blister blight is carried out on the principle that a certain amount of sunlight per day is likely to kill the majority of the spores that could cause infection at that time. Therefore, during periods with adequate sunshine the degree of infection is expected to remain within reasonable limits (30 to 35% shoot infestation), and spraying becomes necessary only during periods with insufficient sunshine.

The first stage of the practical application of this system was tested out on a field experiment at St. Coombs (4,500 ft.). The experiment had 8 treatments each replicated 6 times. The treatments were all based on certain arbitrarily laid out sunshine figures and were as follows:—

Treatment 1.— Spraying was carried out only if the average amount of sunshine per day for a 5-day period was less than $2\frac{1}{2}$ hours, but at intervals of not less than 10 days. That is to say, following the first spraying, the next would be done after 10 days, if the second 5-day period (6th to 10th day) had less than an average of $2\frac{1}{2}$ hours of sunshine per day, irrespective of weather conditions during the first 5-day period. In case the sunshine during the second (and/or 3rd, 4th, etc.) 5-day period was not below the critical level (had more than $2\frac{1}{2}$ hours sunshine) spraying would be postponed until after the next 5-day period that was found to have had less than an average of $2\frac{1}{2}$ hours sunshine per day.

Treatments 2 and 3 were similar to 1 but with the minimum sunshine required set at average of 3 and $3\frac{3}{4}$ hours per day, respectively.

Treatments 4, 5 and 6 also had the minimum required sunshine set at $2\frac{1}{2}$, 3 and $3\frac{3}{4}$ hours, respectively, but the period was fixed at 7 days. Here spraying was carried out on the day following a 7-day period during which the total amount of sunshine recorded was below the set minimum.

Treatment 7.— Control — sprayed every 9–10 days.

Treatment 8.— Control — untreated.

All spray applications were made using hand-operated Senior Knapsack sprayers with a 50% copper fungicide at the rate of 6 oz. per 15 gallons.

The degree of infestation on the experimental plots was assessed in the usual manner by plucking at random 10 bushes from each plot of 1/20th acre and determining the percentage of shoots whose third leaves carried infection.

3. Results and Discussion

The experiment was conducted over a period of about 8 months during which time 46 assessments for blister blight infestation were made. The average monthly infestation and the number of sprays for each treatment are given in table 1.

TABLE 1.—*Average monthly shoot infestation of plots sprayed according to th amount of sunshine recorded over 5-day and 7-day periods*

Treatment	% MONTHLY SHOOT INFESTATION									Total number of sprayings
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average	
5-day										
(1) < $12\frac{1}{2}$ hrs.	14.5	42.2	45.2	16.0	24.7	28.1	20.9	20.1	**26.5**	11
(2) < 15 ,,	13.3	37.2	39.4	17.4	23.5	23.5	15.0	17.5	**25.5**	11
(3) < $18\frac{3}{4}$,,	15.3	33.8	26.0	12.3	16.5	18.1	15.9	19.5	**19.7**	13
7-day										
(4) < $17\frac{1}{2}$ hrs.	18.4	47.7	42.9	17.7	14.1	27.7	23.3	25.7	27.2	9
(5) < 21 ,,	17.5	46.3	39.0	14.6	12.8	21.2	21.8	33.4	25.8	11
(6) < $26\frac{1}{4}$,,	15.9	45.3	34.8	12.7	17.7	19.5	18.6	12.6	22.1	17
(7) Control sprayed	14.0	26.0	28.5	7.7	22.1	10.7	17.1	8.3	**16.8**	24
(8) Control untreated	15.9	43.4	54.8	19.3	48.7	37.8	39.1	32.5	36.2	9
Sign. Diff. P=0.05	10.6	13.8	7.4	5.5	10.0	6.2	11.0	8.8	5.9	—

It will be seen from the table that treatment 7 which is similar to normal estate praying gave the best protection. However, treatments 3 and 6 which were based on an average sunshine of $3\frac{3}{4}$ hours over a 5 day and 7-day period respectively gave protection not significantly different from treatment 7. The important point to note here is that in the case of treatment 3 only 13 sprayings were given and for 6, 17 sprays as compared with 24 sprays for the control (7). These figures clearly indicate that when spraying is carried out on the basis of sunshine records, a considerable saving in spraying costs could be achieved. In fact, even spraying based on an average of $2\frac{1}{2}$ to 3 hours sunshine daily, whether over a 5-day or 7-day period gave reasonable protection (as seen in treatments 1, 2, 4, and 5` during

most months. This was, however, obtained with less than half the number of spraying rounds compared to the control (7). The infestation in the case of these treatments exceeded the tolerance limit of 35% during two months only. During these two months — June and July — the best protection was achieved when spraying was carried out on the basis of an average of $3\frac{3}{4}$ hours daily sunshine per 5-day period.

These figures tallied with other experimental data (2) which indicated that about 4 hours of sunshine daily are adequate to keep blister blight infestation within reasonable limits.

The fact that none of the experimental treatments is (judging from the figures) better than the routine estate spraying, should not be considered a decisive drawback, as the omission of a certain number of sprayings must inevitably lead to a slightly greater incidence of blister blight. A better result than from normal spraying could be achieved with the present fungicides only by spraying at shorter intervals during periods when the amount of sunshine is very low.

Further experiments carried out during the N.E. Monsoon on two estates in the Nuwara Eliya district at elevations of 5,000 to 6,000 ft. which are subject to severe mist, confirmed our findings on St. Coombs, that sunshine data could be used as a guide in timing spraying rounds.

5. Conclusions

It appears from the above results that a spray-timing system, based on the principle that spraying is discontinued following a 5-day period during which sunshine exceeds $3\frac{3}{4}$ hours daily and resumed when sunshine drops below this level, can achieve a protection not much less effective than routine spraying while markedly reducing the number of spraying rounds.

The use of a 7-day period for the determination of sunshine appeared feasible but was found somewhat less efficient as regards protection and spraying costs. The use of a period longer than 7 days would seem to be inadvisable as the chances are that many days within that period may be favourable for infection though the average sunshine for the whole period may not be below the required minimum.

It can be concluded, therefore, that a spray-timing system based on sunshine data shows considerable promise for application on a field scale.

6. Application of the System on a field scale

No forecasting system is of any use unless it can be applied on a field scale. This system based on sunshine data has so far not been tested out on a field scale and it is, therefore, not our opinion that superintendents of estates should straightaway try this scheme on an estate scale. Several trials have been laid out to test the suitability of this scheme on a field scale and until further information is available, we are not in a position to recommend the method at present. However, it would be appreciated if superintendents would try out the method on an experimental scale on one or two fields on their estates so that we could be appraised of the practical difficulties involved. It is our opinion that the introduction of the spray-timing system on whole estates is likely to introduce numerous difficulties at the managerial level.

(1) In the first place it will be necessary to decide on a regular plucking round. This would be required to determine a period between plucking rounds over which the sunshine is to be recorded. It is our view that in the case of plucking rounds varying from 8 to 10 days it will be necessary to have two periods. The condition that two sunshine periods cover the interval between two plucking rounds is essential

in order to ensure that spraying, if required, will always be done either midway between two pluckings or on the day following plucking. Otherwise, it may happen that plucking has to be done soon after spraying thereby resulting in the copper content of the made tea exceeding the tolerated limit.

(2) For plucking rounds of 7 days or under it will not be necessary to divide the interval into two periods and the whole interval could be treated as one period. It should, however, be borne in mind that it is better to keep the interval as low as possible or else it may be necessary to raise the minimum total sunshine so as to avoid risks.

(3) It will further be necessary to appraise the disease liability of the different fields. For instance, it may be necessary to raise or lower the minimum level of 4 hours daily sunshine or 20 hours for a 5-day period to suit local conditions. On those fields which are normally subject to heavy infection, spraying would have to start fairly early and proceed into the wet season proper. In such instances it may be advisable to adopt a higher minimum limit of say 5 hours sunshine daily, to be reduced later to 4 hours.

(4) Indications are that during the second half of the monsoon when the weather becomes more intermittent and the infestation usually abates, spraying on a basis of 3 to 4 hours sunshine daily may be possible. It is likely that the number of spraying rounds during that period could be reduced to about half while maintaining adequate protection.

(5) Further, it is strongly recommended that this scheme should not be applied to tea coming into bearing either after planting or subsequent to pruning.

(6) To start the scheme on an estate, division or field, the area selected has to be divided into 10 blocks in the case of a plucking interval of 10 days or more. Each of these blocks will have to be plucked on successive days and sprayed on the following day. Subsequently plucking should as far as possible be carried out at regular intervals, but could be shifted one day on either side of the due date. Care should, however, be taken to see that 3 to 4 days elapse between the last spraying and plucking. Spraying should be carried out as described earlier and should be done as far as possible on the due dates. It is very likely, especially in the thick of the monsoon, that 2 blocks or one-fifth of the estate may have to be sprayed on one day, and if a postponement is made 2/5 of the estate may have to be sprayed the next day.

It is very difficult to foresee the practical difficulties involved in adopting this scheme without field experience. However, the following conditions will have to be adhered to if the scheme is to be applied on an estate scale: (1) as far as possible plucking has to be done at regular intervals, and (2) spraying has to be done strictly on the due dates, as postponement may double the work for the next day. It may be necessary to spray as much as one-fifth of the whole estate on a single day which would necessitate twice the normal gang strength of spraying men and spraying equipment. When spraying is based on this scheme the work will not be distributed uniformly but will be concentrated over a few days at a time. Hence the greatest problem that would face the Superintendent would be to provide alternate work for this greatly enhanced spraying gang.

Finally it should be stated that savings on the cost of blister blight control can only be achieved by reducing the number of spraying rounds. This will mean running some risks which can be minimised by introducing special rapid methods of control.

(7) Summary

This paper deals briefly with a new method of timing blister blight spraying according to sunshine records. A spray-timing system based on an average daily

sunshine of 3–4 hours recorded over 5-day and 7-day periods provided adequate protection, while reducing the number of spraying rounds by about 40% over a period of about 8 months.

This method of spraying shows considerable promise as regards its application on estates. However, it involves some practical difficulties a few of which are briefly discussed here.

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OILSPOT OF TEA LEAVES—A NEW DISEASE?

D. Mulder and N. Shanmuganathan

During the last two or three years a few upcountry estates at elevations between 5,000 and 7,000 ft. have been alarmed by the increasing occurrence of an apparently hitherto unknown leafspot disease. The condition was tentatively given the name "spotted leaf" on one estate but was later renamed as "oilspot," the latter being a more descriptive expression. The disease has now been found on seven estates a few of which have an incidence of about 5% in badly-affected fields.

The symptoms can be described as follows: The spots which first develop on the underside of the leaf are small and numerous. They start as little translucent spots which later develop a dark grey colour in the centre and finally appear as dark brown spots in reflected light. These show a translucent halo in transmitted light. The spots have no characteristic shape or size and in severe cases may coalesce and colour the whole undersurface of the leaf dark brown. Some bushes develop excrescences on the underside of the leaf and the spots therefore appear slightly elevated as in the case of scab. The difference with scab is not always quite clear. Scab, however, develops only on the older leaves and is, therefore, a harmless disease. Oilspot on the contrary develops on young and very tender leaves, and leads to severe defoliation. The new leaves which develop on the affected shoots are small and underdeveloped, and these too eventually fall. This successive defoliation leads to starvation and finally to the dieback of the shoots from the tips and death of part of the bush.

The disease usually starts on one side and gradually spreads to the rest of the bush. This may take a very long time. Some of the bushes showing the disease on one side had dead stumps on the same side, indicating the long duration of the progress of the disease.

The pattern of symptoms largely depends on the kind of bush affected. So far no preference for any type of tea has been found to exist in the field. Low jat and high jat seedlings are both affected. The appearance of the disease is, however, completely different in the two jats. The symptoms are more acute and the spots bigger, but due to the faster growth less deleterious, on high jat than on low jat bushes. On low jat bushes the development is slower but defoliation is more complete, and ultimate death of part of the bush more likely.

The experience of one planter is that, after pruning, the symptoms return in the new growth on the same side of the bush. This seems to indicate the presence of a causative agent in the bush instead of in the leaves. This phenomenon can, however, be explained in other ways also.

As to the causes of the disease no conclusions have yet been drawn. Work on the isolation of a parasitic fungus has shown consistently the presence of a certain fungus in the affected leaves. It is still doubtful, however, whether this fungus is the cause, as inoculation experiments so far have not led to any infection. Moreover, reports on the identification of this fungus have indicated that it is normally not able to cause a spot on leaves, but is known to occur on the bark of older branches.

FIG. 1.—Oil spots and corky excrescences on lower leaf surface

FIG. 2—.Oil spots on the flush

FIG. 3.—Small leaves on some of the shoots

Therefore the fungus that has been isolated is probably merely a secondary invader of tissue that, for some reason, became liable to infection.

We have failed so far to isolate a bacterium from the young spots.

Trials with cuttings from affected bushes show that the new growth from leaf cuttings is normal. This would indicate that either no parasite is present, or for some other reason the new growth was not infected. As the moisture conditions around cuttings which are shaded and watered frequently are favourable for infection, one would expect the new growth to be infected. Therefore, it could be concluded that no parasite is present, in which case we would have to look for a cause in the roots. The fact that diseased bushes show the disease, after pruning, on the same branches might further lead one to think on these lines. However, the roots of diseased bushes that have so far been examined did not show any abnormality.

In order to ascertain whether temperature had any effect on the spread of the disease in a bush, one bush which showed the symptoms on one side was transplanted from 5,000 ft. elevation to St. Coombs at 4,500 ft. where the disease had not occurred so far. It was thought that by transferring the bush to warmer weather conditions the spread of the disease in the bush would be checked and that it would recover. The result was, however, to the contrary. The transfer took place on August 16th. The recovery of the bush from transplanting was normal, but in January the bush started to show symptoms on all the leaves, and by April 13th defoliation was progressing rapidly.

With a view to determining whether fungicides were effective in the control of the disease, a spraying experiment in which a copper oxide, a zinc carbamate and a fungicide known as Captan were used at five day intervals (from 29-1-59—28-4-59) was carried out. This showed, however, that fungicides were ineffective in controlling the disease.

In the literature we find a description by Bitancourt and Jenkins (1) of scab caused by a fungus *Elsinoe theae* which belongs to a group of fungi causing anthracnoses. Tourje (2), however, in a recent book on "Camellia culture" cites work done by Plakidas *et al* in Louisiana. The latter first isolated *Sphaceloma* sp. from different types of scab but failed to prove that this was really a parasitic fungus. Inoculations gave no result and spraying with fungicides did not affect the disease. Plakidas concluded that scab is physiogenic in nature and caused by fluctuations in soil moisture. He was able to control scab by the use of sprays such as wax solution which reduce the transpiration. This would indicate that at least a certain type of scab, *e.g.* corky excrescence, is related to soil moisture and conditions controlling transpiration.

Because of the fact that oilspot develops only in areas with very high humidity and rather low temperatures it is possible that oilspot might also be due to a lack of balance between the uptake of water by the roots and its transpiration by the leaves. The invasion of weakened tissue by a weak parasite like the fungus that has been isolated by us, could thereafter cause the defoliation and death of branches. Further research to test the above hypothesis is, therefore, necessary.

References

1. Tourje, E. C., "Camellia Culture" 1958 (Macmillan) from which the following are quoted:
   (*a*) Plakidas, A. G., 1948, American Camellia Yearbook.
   (*b*) Plakidas, A. G., 1951, American Camellia Yearbook.
2. Plakidas, A. G., 1948, *Phytopathology*, **38,** 21.
3. Bitancourt, A. A. and Jenkins, Anna E.—*Aquivos do Instituto Biologics*, **10,** 1939: 193.

A NEW TYPE OF INFRA-RED MOISTURE TESTER—THE ASE MOISTURE BALANCE

E. L. Keegel

This instrument is similar in its operation to the 'Kaybee' infra-red moisture tester, details of which were published in the *Tea Quarterly*, Vol. XXV—Part 4—December, 1954. It has, however, a number of advantageous features not possessed by the latter. These are as follows:—

1. A built in automatic time switch, which switches off the lamp after the set period of drying.
2. A magnetic damping device, which brings the balance pointer to an almost immediate rest thus considerably shortening the weighing time.
3. A spirit level.
4. Easy adjustment for zero reading. Only one screw has to be turned, which is easily accessible.
5. All movable parts are enclosed, thus minimising the precautions necessary for protecting the instrument from dust and air currents.
6. A magnifying glass for more accurate readings.

A balance of the type almost identical with that shown in the accompanying photograph underwent many trials, and the results have proved to be satisfactory. It was found that for tea the optimum conditions of operation were:—

a. A sample weight of 10 gms.

b. A drying period of 10 minutes.

c. A height of 15.5 cms. of lamp above the pan containing the sample when the balance pointer indicates zero on the scale. This corresponds to a setting of 4 on the rod carrying the lamp.

Under these conditions the error was negligible for a moisture range of 2 to 9%. In view of the satisfactory performance of the instrument and relative ease of operation it is strongly recommended for use in the tea industry.

Since tea, whether it be graded or not, is never uniform in size and character, possible errors in sampling should not be overlooked. It is therefore particularly useful to repeat a test on a duplicate sample, and the average figure taken. This precaution has been found necessary even in the case of moisture determinations by standard oven methods.

It will be noted from the photograph of the instrument that the scale reading is from 0–25%. This has been a recent modification, but models having a scale calibrated 0–20% with sub-divisions of 0.1% are also available. The latter type, which was tested, would be preferable since the scale in the former is sub-divided 0.2%. More changes have been made in the instrument since the first one received by us was tested, presumably with a view to extending its use. For example, the 15 minute timer has been replaced by a 30 minute unit

At the same time two important additions have been made to increase the accuracy of the instrument. These are:—

1. A thin metal cowling is arranged around the pan, the purpose of which is to reduce disturbances due to air currents. This clips into holes on the housing, and has to be withdrawn before the front cover can be removed.
2. A cowling has also been arranged around the zero adjustment screw. In practice this does occasionally become disturbed by the operator. The photograph shows the latest model with all these modifications incorporated. The magnifier to the scale is not shown.

The balance is manufactured in Germany and the suppliers are the Shandon Scientific Company Ltd., 6, Cromwell Place, London, S.W.7 from whom further particulars can be obtained. Current prices are:—

Moisture balance complete, scale calibrated 0–25% with sub-divisions of 0.2% readable to 0.1%	£ 37	16	0	
Moisture balance complete, scale calibrated 0–20% with sub-divisions of 0.1% readable to 0.05% ...	42	16	0	
Spare stainless steel sample pan	—	8	0	each
Spare stainless steel sample pan—per dozen	4	15	0	
Spare infra-red lamp 250 Watts, 240 Volt A.C. ...	2	10	0	
Packing and delivery charges f.o.b. Hamburg will amount to	4	10	0	

If the lamp is to be operated from a D.C. mains, the timer will have to be omitted. This will reduce the cost of the instrument by £.3.10.0.

MISCELLANEOUS NOTES

REVISED SUGGESTIONS FOR DOLOMITE AND MAGNESIUM SULPHATE APPLICATIONS TO TEA

J. A. H. Tolhurst

We have decided to make slight alterations in the recommendations regarding the application of dolomite, and the following notes are based on the assumption that dolomite will be used as part of the standard manuring policy on all tea.

1. Soil pH

As a result of experiments we do not now consider it necessary to check the soil acidity before dolomite is applied, *unless* it is known that limestone rock outcrops occur in particular areas. In such instances soil samples may be taken for pH test, at varying distances below visible outcrops. The effect of such limestone on the soil acidity is not normally appreciable outside a fifty yards radius, unless small boulders or stones have become detached from the outcrop and moved downhill.

2. Mature tea

As a general guide to rates of application the following table is given:—

Yield of tea Cycle average, lbs./acre/annum	Dolomite lbs./acre/annum
Up to 750	70
750 to 1,200	100
Over 1,200	130

These rates are intended to be associated with normal applications of the standard N.P.K. mixture (*e.g.* T.500 and variants), and may be altered whenever considered desirable. They should be regarded as prudent minimum doses.

3. Young tea

When replanting tea it is suggested that dolomite should be broadcast before holes are cut for the young tea plants, and that the middle category of the above table represents a reasonable dose. In view of the slowness of action of dolomite, and the demands made on magnesium supplies by rapidly growing young plants we suggest that magnesium sulphate be added to the N.K.P. manure in the following proportions, assuming that the magnesium sulphate used contains 24% MgO.

Manure	Additional magnesium sulphate as lbs. per 100 lbs. of N.P.K. mixture
Inorganic, *e.g.* Young Tea Mixture (T. 175 or 180)	14
Organic, *e.g.* balanced animal meals. Various trade names	14

This proportion is approximate, and we do not claim that the above ratio of magnesium to any other nutrient in the mixture is of fundamental importance. Varying effects of the soil colloids in different areas, and the varying ability of different clones to absorb the nutrients supplied will mean that no single mixture would be optimum for all situations. It is wiser to give a provisional magnesium application which, it is believed, is on the generous side, rather than to draw on the preliminary soil analyses so far available and attempt at the moment to give a scientifically based proportion which may later prove to be inadequate under some conditions.

4. **Application**

The application of magnesium sulphate to young tea is, naturally, inseparable from the application of the N.P.K. manure. Dolomite, although the dose has been expressed on an annual basis, may still be applied *once per cycle*, or even once every other cycle where the cycle is of two years duration or less. If the standard manure is broadcast it would be desirable to allow a few showers of rain to fall before broadcasting the dolomite. Apart from this stipulation no other precautions are necessary and no separate cultivation is required for a dolomite application.

References

Tolhurst, J. A. H. (1956): Dolomite. *Tea Quarterly*, 27 (1) pp. 38–41.

Tolhurst, J. A. H. (1959). General principles of soil cultivation and of methods of manure application to tea, *Tea Quarterly*, **30** (1), pp. 19–29

Visser, T. and Kehl, F. H. (1958): Selection and Vegetative Propagation of Tea, *Pamphlet* No. 3, p. 7.

A NOTE ON THE STORAGE OF THE AMBROSIA FUNGUS BY THE SHOT-HOLE BORER BEETLE (*XYLEBORUS FORNICATUS EICH.*)

E. F. W. Fernando

A study of the head of *Xyleborus fornicatus* Eich showed that in the female there were two sacs on either side of the head situated anterior to the brain. These two sacs open by two ducts into the upper part of the oral cavity. By means of specific staining it was revealed that these sacs contained the spores of the ambrosia fungus *Monacrosporium ambrosium* Gadd and Loos. These spores were not found anywhere else in the body of the female, nor in the adult male. They are transmitted by the female into the galleries to start a new culture of the fungus for the successive generations of the larvae.

This method of storage of the ambrosia fungus by *Xyleborus fornicatus* Eich differs from all storage methods seen in species of ambrosia beetles so far described.

A comprehensive description of the storage of the ambrosia fungus by *Xyleborus fornicatus* Eich, will be published elsewhere.

SUBMISSION OF SPECIMENS FOR DIAGNOSIS AND REPORT

D. Mulder

Further to our miscellaneous notes on Pathological matters in the *Tea Quarterly* publication of March, 1944, Vol. XXV, Part 1, pages 17 and 18 on the above subject, we would appeal to you to give your kind attention to the following when submitting specimens for our diagnosis and report. This would simplify our work considerably.

I. **Dead or diseased bushes**

Please state:—

1. Whether isolated or from a patch
2. Length of time that the condition has been noted
3. Soil type and drainage
4. Proximity of shade trees (give species) or shade tree stumps
5. Unusual climatic conditions (drought, etc.)
6. Rainfall for last 5 months
7. Recent cultural operations (manuring, tipping, lopping or removal of shade, thatching, etc.)
8. When last pruned
9. Condition of the bush at the time of uprooting.

II. Packing of material for transport

In addition to the information asked for, the following points should be borne in mind in packing material for transport:—

1. Bushes suspected of root disease should always be completely enclosed to avoid dissemination of disease in transit. Whenever possible they should be sectioned down the centre. Each bush should bear an individual label, corresponding with a label placed on its site of removal from the field.
2. Leafy material should always be packed in a damp condition in order that they may arrive in as fresh a condition as possible. This can easily be accomplished by packing the material in polythene bags (available from Messrs. Imperial Chemical Industries, Ltd., P.O. Box 362, Colombo) with moist cotton wool. In the absence of the above packing material, damp moss or plantain leaves, in ample quantity, could be used.

III. Posting of material to the Institute

It would be preferable if the specimens are posted or railed from your end on the Monday of the week, so that the material would reach us in the course of the week for our diagnosis and report. Material posted on a Friday or Saturday is liable to be delayed unduly in transit, and as a result will be dried out or decomposed before the sample can be examined.

Much waste of time, material and money can be avoided in this way.

PROVISIONAL LIST OF APPROVED CLONES

(Prepared by the Tea Control Department in consultation with the Tea Research Institute)

Tea Research Institute (St. Coombs Estate, Talawakelle)	Clone Nos.	23, 25, 740, 777, 1076, 1114, 1294, 1526, 2016, 2020, 2021, 2022, 2023, 2024, 2025, 2026.
Agra Ouvah	,, ,,	A/O.
Balangoda Group	,, ,,	MT12, MT13, MT16, MT17, MT18, MT20, DG3, DG7, DG39, DG43, DG51, DG52, DG54, DG56, DG58, DG66, DG67.
Bogawana	,, ,,	B. 8, B. 95.
Cannaverella Group	,, ,,	CV4/B1, CV5/B1, MG3/B1, NK4/B29.
Carolina Group	,, ,,	2/18, 3/1, 6/3, 7/3, 7/10.
Chapelton Estate	,, ,,	C171.
Craighead Estate	,, ,,	CH13.
Diyagama Group	,, ,,	A, B, C, D, DI, DN, E, G, K, N, P, 1, 2, 3, 4, 6, 7, 12, 13, 15, 19, 21, 22, 27.
Drayton Estate	,, ,,	DT1, DT95
Fernlands Estate	,, ,,	F4, F8.
Hellbodde Estate	,, ,,	16/13, 16/14, 16/19, 13/4, 2A/1.
Hunasgeria Group	,, ,,	1, 5.
Kenilworth Estate	,, ,,	13/3, 15/2, 15/7, 15/8, 15/13, 16/3, 22/1.
Kew Estate	,, ,,	4A2, 4A4, 14/1.
Kirkoswald Estate	,, ,,	K136, K145, K150.
Kolapatane Estate	,, ,,	1/8, 82/7B.
Moray Estate	,, ,,	MG, MH.
Nayabedde Estate	,, ,,	NAY-3.
Neluwa Estate	,, ,,	NL 3/1, NL 4/2, NL 8/3.
Niriella Estate	,, ,,	1B7, 3B22, 3B30, 3B39, 12B30.
Ottery Estate	,, ,,	OT.5/8, OT5/18, OT5/30, 6A/35, 1B/3.
Ouvahkellie Estate	,, ,,	OK1, OK2, OK3, OK4, VK1, VK9.
Pindenioya Estate	,, ,,	PO5.
Pitakande Estate	,, ,,	SW11.
Queenstown Estate	,, ,,	QT 1/3, QT 1/5, QT 2/3, QT 2/5, QT 3/4, QT 4/4, QT 7/1.
Rutland Estate	,, ,,	RL.A, RLE.
Sirikandura Estate	,, ,,	S106, S123.
Talankande Estate	,, ,,	TK42, TK45, TK48.
Tangakelle Estate	,, ,,	CY9.
Tillicoultry Group	,, ,,	9.
Uda Radella Estate	,, ,,	UR12.
Uva Highlands Estate	,, ,,	UH 3/4, UH 9/3.
Wootton Estate	,, ,,	W3, W14.

This will be revised from time to time

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD IN THE CHAIRMAN/COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, ON FRIDAY, 29th AUGUST, 1958, AT 2.30 P.M.

Present.—Messrs. F. Amarasuriya (Chairman), P. W. Keun (Chairman, Agency Section, Planters' Association of Ceylon), H. Creighton (Chairman, Planters' Association of Ceylon), C. Selwyn Samaraweera (Chairman, Low-Country Products Association of Ceylon), H. E. Peries, O.B.E. (Deputy Secretary to the Treasury), B. Mahadeva (Tea Controller), R. C. Scott, C.B.E., W. H. W. Coultas, N. M. Sanders, G. K. Newton, R. J. Gilmour, R. D. Wedd, Dr. A. W. R. Joachim, O.B.E. (Acting Director) and Mr. G. A. D. Kehl (Secretary).

Messrs. V. G. W. Ratnayaka, M.B.E., and J. L. D. Peiris intimated their inability to be present.

1. The notice convening the meeting was read.

The Chairman welcomed Mr. P. W. Keun, Chairman of the Agency Section of the Planters' Association of Ceylon.

He informed members that the meeting originally fixed for the 5th September had to be advanced for the 29th August as he, Mr. Coultas and Mr. Sanders were to accompany the Tea Delegation to the U.S.S.R. on the 2nd September.

2. **Minutes of the Meeting held on 27th June, 1958**

The minutes were confirmed.

3. **Matters Arising out of the Minutes**

(i) **Item 5 (iii)—Foreign Aid Services of an Expert Nematologist**

The Acting Director reported that the Treasury had advised him that the Institute's application for the services of an Expert Nematologist was due for consideration under the 1959 estimates and that they would do their best to see that this assignment was filled as early as possible.

(ii) **Item 11—Visit of Mission to study the Soviet Tea Industry**

The present position in regard to this matter was fully discussed and it was decided that members of the Board were to be advised of the final issue relating thereto.

4. Membership of the Board and Committees

(i) Board

Reported that Dr. M. F. Chandraratna was away from the Island till about the 12th September and that Mr. S. S. H. Silva, Deputy Director of Agriculture (Administration), had been nominated to act for him.

(ii) Committees

(*a*) Appointments Committee. Mr. B. Mahadeva was nominated as an additional member.

(*b*) Experimental and Estate Committee. Reported that Mr. A. J. Pelly Fry was nominated to take the place of Mr. T. Kane who had resigned. A vote of thanks was recorded for the long and valuable services rendered by Mr. Kane.

5. Minutes of the Finance Committee Meeting held on 27th June, 1958

The additional vote of Rs. 7,000/- for the new gas plant was approved.
The minutes of the Finance Committee were approved.

6. Minutes of the Low-Country Committee Meetings held on 26th July, 1958, and 26th August, 1958

(i) Minutes of Meeting held on 26.7.58

Mutwagalla Estate. Reported that in view of the delay and other disadvantages involved in adopting the acquisition procedure through Government, it was decided to arrange for the purchase of the estate in the normal way through the Institute's lawyers and that the matter was now in their hands.

(ii) Minutes of Meeting held on 26.8.58

Reported that the Committee had visited Mutwagalla Estate on the 26th August and the decisions made at the meeting on that date were recorded in the minutes which were tabled.

The minutes of the meetings held on 26th July, 1958, and 26th August, 1958, were approved.

7. Minutes of the Administrative Committee Meeting held on 1st August, 1958

(i) Reported that 16 members had approved the recommendation of the Committee in regard to the Deputy Director, Acting Director and Mr. J. A. H. Tolhurst (reference Circular No. A. 44/58).

(ii) Page 4. Item 4 (i)—Technology Department

The Acting Director informed members that at the Appointments Committee meeting held that morning a Research Assistant to Mr. Keegel had been appointed.

(ii) **Additional Votes**

The following estimates recommended by the Committee were approved:—

(*a*) Water Supply:				
(1) Enclosure to reservoir ...	...	...	Rs.	3,800/-
(2) Filters for bungalows ...	...	...	,,	1,000/-
(*b*) Kew Bicentenary Commemoration Fund ...		...	,,	1,400/-
(*c*) Delegation to the Soviet Union ...		...	,,	40,000/-
(*d*) New Buildings		...	,,	300,000/-

It was noted that the vote for buildings was an estimated figure given by the Architects and that the final figure would be put up to the Board after tenders had been called for.

Mr. Gilmour suggested that it would save much time of the Board if members would send to the Secretary any comments or suggestions on the Committee minutes which they had to make instead of discussing over again what had already been fully dealt with by the various Committees. Agreed.

The minutes of the Administrative Committee meeting were approved.

12. Any Other Business

(*e*) **Symposium on Rehabilitation and Replanting of Tea**

At the request of the Acting Director this item was taken up for discussion before Mr. Mahadeva left the meeting.

The Acting Director suggested that a Symposium on Rehabilitation and Replanting of tea be held towards the latter part of November this year in order to obtain the views and experiences of the planting community on this very important matter. At the moment the Institute had not got adequate information on rehabilitation and replanting. If all the information could be pooled together it would be possible to get a clearer idea of the recommendations the Institute would make to the planting community on this matter. It would also be a good opportunity for the Tea Controller to indicate to them the administrative aspects of the proposed rehabilitation scheme. In this connection he referred to the questionnaire he had already issued to planters on the subject.

Mr. Mahadeva strongly supported the Acting Director and said that mid-November would be a suitable time to hold the Symposium. He thought the Act would not come into force before then.

The Acting Director said that Mr. F. H. Kehl would have by then returned from his visit to North and South India and his views and impressions could be made the subject of a paper at the Symposium.

The Board agreed to hold a Symposium in Colombo, and the following steering committee was appointed to make the necessary arrangements:—

The Chairman
The Acting Director
Mr. G. K. Newton
Mr. P. W. Keun
Mr. H. Creighton
Mr. N. M. Sanders
Mr. B. Mahadeva

Mr. Mahadeva left the meeting.

8. **Experimental and Estate Committee Minutes of the Meeting held on 9th August, 1958**

The following votes recommended by the Committee were approved:—

(*a*)	Plant Physiology Department — Special shading experiment	Rs.	14,000/-
(*b*)	Technology Department — Freezing unit	„	5,000/-
(*c*)	Pathology Department — Shed for grafting and budding experiments	„	7,500/-
(*d*)	Estate — Tarry Nipper	„	4,600/-

With regard to the freezing unit, the Acting Director said that a provisional patent in the Institute's name had been applied for as a matter of form. Members would be kept informed of the progress of the experiment.

Mr. Gilmour suggested that in future a summary of the additional votes recommended by the Committees should be appended to the minutes. This would save the Board much time. Agreed.

Mr. Keun left the meeting.

In reply to a question by Mr. Sanders in regard to the standard of the *Tea Quarterly*, the Acting Director indicated that it was not proposed to lower it in any way. Articles of a highly technical nature would be published in the new "Technical Communications" which it is proposed to publish and copies of which would be sent to those receiving the *Tea Quarterly*. It was agreed that condensed versions of the "Technical Communications" should be published in the *Tea Quarterly*.

The minutes of the meeting of the Experimental and Estate Committee were approved.

Messrs. Newton and Coultas left the meeting.

9. **Minutes of the Meeting of the Appointments Committee held on 12th August, 1958**

(i) Reported that Mr. H. J. Balmond had accepted the post of Chief Administrative Officer and would be assuming duties on 1st November, 1958.

(ii) Approval was granted for the appointment of an additional Research Assistant for virus diseases in the Plant Pathology Department.

(iii) Reported that the appointments of Mr. S. Balasubramaniam and Mr. R. L. de Silva as Research Assistants in Plant Physiology and Plant Pathology respectively were approved, *vide* Circular No. A. 43/58.

(iv) Reported that the Appointments Committee at its meeting held that morning recommended the appointment of Mr. D. Kirthisinghe as Research Assistant to the Technologist. Approved.

The minutes of the Appointments Committee meeting were approved.

10. **Finance**

Institute's accounts as at 31st July, 1958, were accepted.

11. **Staff**

The following appointments were reported:—

(i) Mr. O. J. Fernando, Clerk of Works, Junior Staff, Grade I.

(ii) Mr. B. P. M. Perera, Technical Assistant, Junior Staff, Grade II, Biochemistry Department.

(iii) Mr. N. de S. Jayasundera, Technical Assistant, Junior Staff, Grade II, Plant Physiology Department.

12. **Any Other Business**

(i) **Annual Report of the Board**

Reported that 16 members had approved the annual report of the Board for 1957, *vide* Circular No. A. 37/58.

(ii) **Seventh Commonwealth Entomological Conference and Sixth Commonwealth Mycological Conference**

Reported that the Administrative Committee had accepted the invitations in principal. Agreed.

(iii) **Wood's Heat Exchanger**

The recommendation of the Administrative Committee that the application from Messrs. Walker & Greig for the installation of a Wood's Heat Exchanger in St. Coombs factory for trial entirely at their expense was approved.

(iv) **Monograph No. 4 — Revised Edition**

The comments made and decisions arrived at the meeting of the Administrative Committee were reported to the Board. On the proposal of Mr. Gilmour it was agreed that:

(*a*) copies of the revised monograph be issued free to estates on the basis of one copy for each tea factory,

(*b*) one copy of the revised monograph be issued free to Agency Houses, Institutes, etc., on the free mailing list as revised,

(*c*) further copies which might be requested by estates and others falling within categories (*a*) and (*b*) be supplied at a charge of Rs. 5/- per copy, and

(*d*) Rs. 10/- be charged for any other sales to the general public.

Sgd. *G. A. D. KEHL,*
Secretary.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD IN THE CHAIRMAN/COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, ON FRIDAY, 5th DECEMBER, 1958, AT 9.30 A.M.

Present.—Messrs. F. Amarasuriya (Chairman), H. Creighton (Chairman, Planters' Association of Ceylon), C. Selwyn Samaraweera (Chairman, Low-Country Products Association), H. E. Peries, O.B.E. (Deputy Secretary to the Treasury), Dr. M. F. Chandraratna, M.B.E. (Director of Agriculture), Messrs. B. Mahadeva (Tea Controller), S. Jinadasa, M.P., G. K. Newton, R. J. Gilmour, R. D. Wedd, J. L. D. Peiris, D. E. Hettiarachchi, Errol Jayawickreme, Reginald Perera, N. M. Sanders, W. H. W. Coultas, Dr. A. W. R. Joachim (Acting Director) and Mr. G. A. D. Kehl (Secretary, Board of Control).

Mr. R. C. Scott had intimated his inability to be present.

1. Notice convening the meeting was read.

The Chairman welcomed Messrs. D. E. Hettiarachchi and Reginald Perera to the Board.

2. **Minutes of the Meetings of the Board held on 29th August, 1958, and 11th October, 1958**

The minutes of the meetings held on 29th August, 1958, and 11th October, 1958, were confirmed.

3. **Matters Arising out of the Minutes**

(i) **Item 12 (*e*) — Symposium on Rehabilitation and Replanting**

Reported that the Steering Committee had met on four occasions and made necessary arrangements for the Symposium which had been voted a success. The Chairman thanked the Steering Committee for the work put in in this connection.

The Acting Director said that the proceedings of the Symposium would be published in the *Tea Quarterly* which he hoped to have ready for issue by about the middle of February next.

In reply to questions raised concerning the Rehabilitation Scheme, Mr. Mahadeva confirmed that he would be prepared to include old tea areas which had been uprooted during the last three years for benefits under the Scheme, provided the actual replanting was done after 6-10-58. He also agreed to consider allowing the

replanting of tea areas from which the old tea had been eradicated owing to root or virus diseases to benefit under the replanting subsidy, provided administrative difficulties could be overcome. He said that he would place the matter before the Advisory Board and furnish a reply in due course.

Mr. Creighton pointed out that it had been agreed that all questions and suggestions should be addressed to the Planters' Association which would take up these collectively with the Tea Controller.

(ii) **Tea Delegation to the Soviet Union**

Reported that the delegation appointed by the Board visited the tea growing areas of Georgia in the U.S.S.R. A report on the Mission would be issued in due course. Expenditure to-date on the Mission amounted to Rs. 32,452.61.

4. Membership of the Board

Reported that consequent on the expiry of the nominations of Messrs. A. G. Divitotawela and W. G. W. Ratnayaka, M.B.E., as representatives of the Small Holders on the Board, the Hon'ble the Minister of Agriculture and Food had nominated Mr. D. E. Hettiarachchi, J.P., U.M., and Mr. Reginald Perera to take their places with effect from 29th October, 1958.

5. Minutes of the Appointments Committee Meeting held on 12th August, 1958

The recommendations of the Committee were accepted and the minutes were noted.

6. Minutes of the Meeting of the Low-Country Sub-Station Committee held on 15th October, 1958

The recommendations of the Committee were accepted and the minutes were noted.

The Chairman reported that at the meeting held on the morning of the 4th of December, the Low-Country Committee recommended that (1) Mutwagalla Estate be purchased as suggested by the Permanent Secretary, Ministry of Agriculture and Food, subject to acquisition proceedings being taken immediately the Tea Research Ordinance was amended to include statutory provision for acquisition of property for the Board under the Land Acquisition Ordinance, and

(2) that the staff of the estate including the labour force should be taken over by the Institute in accordance with the terms and conditions as approved by the Ceylon Estates Employers' Federation.

Considerable discussion followed on the procedure of first purchasing the estate and later acquiring it under the Land Acquisition Act. It was pointed out that the amendment to the Tea, Rubber and Coconut Research Ordinances to enable land to be acquired for the research institutes was passed by the House of Representatives on the 4th December. The Board accordingly decided that Mutwagalla Estate should be acquired in the normal way. Mr. H. E. Peries agreed to have the acquisition proceedings expedited, and he hoped to make it possible for the property to be in Institute's hands by March/April next.

The Committee's recommendation regarding staff and labour force was accepted.

7. **Minutes of the Meeting of the Experimental and Estate Committee held on 25th October, 1958**

Mr. Coultas briefly reviewed the progress made regarding the investigations which were being carried out at the Ceylon Institute of Scientific and Industrial Research. He said that progress had been satisfactory. Four samples of instant tea had been produced but none of them gave anything like the standard brew of tea. Dr. Sundralingam was quite sanguine that they would succeed eventually in producing the desired type of instant tea. At present two of their Chemists, who were working whole time on this project, were at the Institute spending some time studying conditions there.

The recommendations of the Committee were accepted except those of the estate estimates which were to be considered under Item 9 — Finance. The minutes were noted.

8. **Minutes of the Meetings of the Administrative Committee held on 29th August, 1958 and 7th November, 1958**

Chief Administrative Officer

It was reported that Mr. A. St. V. Wijemanne who was offered the post of Chief Administrative Officer had not yet sent his reply. The Acting Director was asked to invite his attention to the offer of appointment and was directed to advertise the post if a reply from him was not received by about the 20th of December.

The recommendations of the Committee, except those regarding the estate estimates, were accepted and the minutes of both meetings were noted.

9. **Finance**

(i) **Institute's Accounts as at 31st October, 1958**

The accounts were accepted.

(ii) **St. Coombs Estate Estimates 1959**

The Chairman reported that at the meeting of the Administrative Committee held on the afternoon of the 4th December, the Estate estimates were further discussed and the Committee recommended their acceptance.

The Committee asked for a directive from the Board as to whether or not the Administrative Committee should have any responsibility for St. Coombs Estate estimates and accounts and if so, in what respects.

The Board after discussion agreed:—

(a) that the Experimental and Estate Committee should be the body responsible for the estate estimates in respect of revenue expenditure.

(b) that capital expenditure should finally be the responsibility of the Administrative Committee. Mr Newton and the Superintendent should be invited to meetings of the Administrative Committee when items of capital expenditure were considered.

(c) that a sub-committee of 3 or 4 members of the Experimental and Estate Committee, as recommended by the Administrative Committee, should, in the first instance scrutinise the estate estimates before they were circulated to the members of that Committee.

(d) that the monthly estate accounts should only be circulated to the members of the Experimental and Estate Committee.

In reply to Mr. Gilmour, Mr. Newton said that 1/6th of the expenditure connected with labour was charged to the Institute as that was the proportion of the labour force used by the Institute for its work.

On the proposal of Mr. Gilmour, seconded by Mr. Coultas, the estate estimates were accepted.

(iii) **Low-country Sub-Station**

It was decided :

(a) that the Low-Country Sub-Station Committee should cease to function when the station was established,

(b) that the Experimental and Estate Committee should deal with both estates — St. Coombs and Mutwagalla,

and (c) that the Administrative Committee should deal with all Institute matters including those of the Low-Country Sub-Station.

It was also suggested that the Experimental Committee might consider St. Coombs Estate matters on the morning of the meeting day and Mutwagalla Estate matters in the afternoon.

10. Staff

(i) Entomologist

An application from Mr. J. E. Cranham, B.A. Hons. (Cantab.), Diploma of the Imperial College, London (Entomology), for the post of Entomologist was tabled. The Chairman said that the Administrative Committee at its meeting held on 4th December recommended that if Dr. Tubbs reported on him favourably the Acting Director be given authority to offer him the post on a salary not exceeding that of any of the overseas recruited staff. Agreed.

(ii) Dr. A. W. R. Joachim, Acting Director.

The Chairman reported that the Administrative Committee recommended that Dr. Joachim's application for leave from the 10th January to 16th February 1959 be granted and that during his absence the technical officers should carry on with their respective duties and that the Administrative Secretary should attend to queries, etc. concerning administrative matters, in consultation with the Chairman where necessary.

The Chief Administrative Officer to take over from Mr. Kehl if he assumed duties by then.

Dr. Visser was nominated to represent the Acting Director in his absence on the Advisory Board of the Tea Rehabilitation and Replanting Scheme. Agreed.

(iii) The Board approved the Administrative Committee's recommendations that the post of Advisory Officer should be first advertised in the local press and that of the Plant Breeder be advertised simultaneously both locally and in the U.K.

The Acting Director said that if the Institute failed to get a Plant Breeder by advertisement he would approach the Colombo Plan authorities.

11. **Any Other Business**

(i) Junior Staff Provident Fund

Mr. D. E. Hettiarachchi was nominated to fill the vacancy created by Mr. Ratnayake's resignation.

(ii) Dr. Mellanby's letter re. donation to Entomological Society.

Reported that the Administrative Committee recommended the payment of a donation of £25 to the Royal Entomological Society. The Acting Director suggested that the payment be increased to £. 50, which the Board approved.

(iii) Pension Scheme for Staff

In reply to Mr. Coultas the Acting Director stated that the pension scheme was deferred for consideration until the Chief Administrative Officer was appointed.

The meeting terminated at 5.30 p.m. with a vote of thanks to the Chair.

(Sgd.) *G. A. D. KEHL,*
Secretary.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT ST. COOMBS, TALAWAKELLE, ON FRIDAY, 6th MARCH, 1959, AT 9.30 A.M.

Present.—Messrs. F. Amarasuriya (Chairman), C. Selwyn Samaraweera (Chairman, L.C.P.A.), B. Mahadeva (Tea Controller), R. C. Scott, C.B.E., J. L. D. Peiris, R. J. Gilmour, R. D. Wedd, W. H. W. Coultas, N. M. Sanders, E. Jayawickreme, D. E. Hettiarachchi, Reginald Perera, Dr. A. W. R. Joachim (Acting Director) and Mr. G. A. D. Kehl (Secretary).

Messrs. S. Jinadasa, M.P., P. W. Keun, H. Creighton and G. K. Newton intimated their inability to be present.

1. Notice convening the meeting was read.

2. **Minutes of the Meeting held on 5th December, 1958**

The minutes were confirmed.

3. **Matters Arising out of the Minutes**

(i) **Item 3 (ii). Tea Delegation to the Soviet Union**

It was reported that reports by:

(*a*) Mr. E. L. Keegel and Mr. F. H. Kehl, and
(*b*) Mr. W. H. W. Coultas and Mr. N. M. Sanders

had been issued to members.

It was decided to publish the report of Messrs. Coultas and Sanders, which represented the views of the entire delegation, in the March 1959 issue of the *Tea Quarterly*.

4. **Membership of the Board and Committees**

(i) **Board**

(*a*) Mr. W. H. W. Coultas had been renominated by the Planters' Association of Ceylon for a further period of three years as from 14th February, 1959.

(*b*) Mr. S. Jinadasa, M.P., had also been renominated by the Ministry of Agriculture and Food for a further period of three years as from 1st January, 1959.

(ii) **Committees**

Mr. W. H. W. Coultas was renominated a member of the Administrative Committee.

5. Minutes of the Meeting of the Administrative Committee held on 4th December, 1958, 6th January, 1959 and 21st February, 1959

(i) **Scientific Advisory Committee in the United Kingdom**

The Board accepted the Administrative Committee's recommendations and agreed that:

(*a*) The Administrative Committee should take the place of the Executive Committee suggested by Dr. Tubbs and be authorised to take decisions on urgent matters without reference to the Board provided they had the approval of *all* members present. Such decisions should, however, be reported to the Board without delay. In the event of any difference of opinion, the matter should be referred to the Board for a decision.

(*b*) A Scientific Advisory Committee in the United Kingdom be set up with Dr. F. R. Tubbs as the Chairman. Dr. Tubbs should be asked to advise the Board on:

(1) the number and personnel of the Committee, and
(2) the payment of expenses incurred by members of the Committee.

(*c*) Members of the Committee should visit the Institute periodically one at a time.

(ii) **Statistical Analysis of Experimental Data**

Reported that Dr. S. C. Pearce was due to arrive in Ceylon on 1st April and would be at the Institute for about seven weeks. He was due to leave Ceylon on the 22nd May, 1959.

A Research Assistant, Mr. N. M. Kappagoda, had been offered the post but had not yet accepted it. In the event of his not accepting the post, the Acting Director was requested:

(*a*) to approach the Department of Statistics for the secondment of a trained statistical officer for a period of two or more months;
(*b*) to advice Dr. Tubbs of the present position regarding the Research Assistant.

The Acting Director said that he would also see the Professor of Mathematics in this connection and obtain his views on the availability of suitable men for the permanent post.

The recommendations of the Administrative Committee as contained in the minutes of meetings of 4th December, 1958, 6th January, 1959, and 21st February, 1959, were accepted.

6. Minutes of the Low-Country Sub-Station Meeting held on 4th December, 1958

(i) **Mutwagalla Estate**

Reported that acquisition proceedings had been instituted by Government and that it was hoped the estate would be taken over by the Institute in a few months.

(ii) **Votes for Low-Country Sub-Station**

A sum of Rs. 25,000/- was voted for the purchase of essential laboratory and field equipment.

(iii) **Staff**

Authority was granted (*a*) to advertise the following posts after the estate had actually been taken over:

(1) Assistant Agronomist
(2) Administrative Assistant
(3) Stenographer/Clerk
(4) Peon
(5) Driver

(*b*) to purchase a suitable vehicle for the sub-station.

The recommendations of the Committee were accepted and the minutes were noted.

7. Minutes of the Appointments Committee Meetings held on 6th January and 21st February, 1959

(i) **Post of Chief Administrative Officer**

The recommendation that Mr. H. J. Balmond be re-offered the post was approved.

The recommendation of the Committee were accepted and the minutes were noted.

8. Minutes of the Meeting of the Experimental and Estate Committee held on 14th February, 1959

(i) **Instant Tea**

The Board noted with interest the progress made on this project and approved of the action proposed in regard to the patent rights.

Mr. Coultas said that the time would come very soon when it would be necessary to use green leaf from a mid-country estate.

(ii) **Tea Essence**

Mr. Coultas brought to the notice of the Board that a large quantity of tea essence (approximately 2 tons) had been imported to Ceylon from the United Kingdom.

After discussion it was decided:

(*a*) to have the tea essence analysed by the Ceylon Institute of Science and Industrial Research,
(*b*) to advise the Ceylon Tea Propaganda Board of the position,
(*c*) to ascertain the legal position in regard to use of tea essence through the Tea Controller.

(iii) **Co-operative Trials**

After considerable discussion the Board agreed that it was their policy ...

(*a*) to continue to house members of the staff on St. Coombs estate, and
(*b*) to utilise to the maximum for experimental purposes of the Institute the land on St. Coombs Estate before contemplating any further acquisitions.

Consequentially it was agreed that
(*a*) 10 acres of St. Coombs land be utilised for the buildings now required, provided the water position was reported to be satisfactory,
(*b*) the views of the staff be obtained regarding land for experimental work,
(*c*) Dr. Pearce's advice be sought in regard to land in relation to the future programme of work,
(*d*) The Institute's brokers, be asked to keep the Board informed if they came to learn of any properties in the vicinity of St. Coombs which might be, or become available for purchase.
(*e*) the scheme in regard to the establishment of a seed garden be postponed for consideration by the Plant Breeder when appointed.

(iv) **Additional Votes — Item 4 (ix) — Technology Division**

The following additional votes were approved:—

Fermenting Chamber	Rs.	8,000/-
Quality test units comprising miniature rollers and driers (in principle)	,,	50,000/-

It was also noted that a sum of Rs. 10,000 would be utilised for chemical analyses of leaf and soil samples to be carried out in the Netherlands from unexpended votes for additional staff which had not yet been appointed.

In reply to Mr. Gilmour, the Acting Director said that details regarding the above additional votes were not available at the time the 1959 estimates were prepared, but he would draw the attention of the Senior Staff that votes for capital expenditure should be included in the estimates for that year.

(v) **Sub-Stations**

In reply to Mr. Sanders, the Acting Director said that the establishment of sub-stations had been approved in principle. He hoped to be in a position at a later meeting to give some definite information regarding the location and establishment of a station for the mid-country.

In reply to Mr. Coultas, he said that unofficial visitors had been appointed to overlook the work of officers-in-charge of the V.P. units at Passara and Neuchatel and the experimental plots at Endane.

(vi) **Messrs. E. L. Keegel and F. H. Kehl's Reports on their visit to India**

It was agreed to publish the reports of Messrs. Keegel and Kehl in the June issue of the *Tea Quarterly*.

(vii) **Packing Materials**

In reply to Mr. Sanders, the Acting Director said that he would ask Mr. Keegel to investigate further the use of packing materials such as multiple bags, plastic material, etc., for packing of tea.

The recommendations of the Committee were accepted and the minutes were noted.

9. St. Coombs Estate

Reported that a profit of Rs. 440,000 (or approximately Rs. 1,670/- per acre) had been made for the year 1958 on a total crop of 320,080 lb. The Board congratulated all concerned on the good results obtained.

10. Staff

(i) Post of Acting Director — Dr. A. W. R. Joachim

The Board unanimously approved the recommendations of the Administrative Committee that Dr. Joachim be appointed Director on an 18-month contract as from 6th March, 1958, on his present emoluments.

The Chairman, on behalf of the Board, thanked Dr. Joachim for having consented to continue till a successor was appointed.

Dr. Joachim thanked the Board for confirming him as Director and assured the members that it was not the matter of salary or position that concerned him. He had found that for the efficient discharge of the duties of a post of responsibility for a long period, it was necessary to have full powers relative thereto.

(ii) Posts of Plant Breeder and Chief Advisory Officer

Reported that the advertisements for the above posts would be sent to Dr. Tubbs after the meeting for necessary action. The post of Plant Breeder would immediately be advertised in the local press.

(iv) New Appointments

The appointment of a Grade II-B officer to be attached to the Agricultural Chemistry Division to assist in soil pH and routine work in connection with the rehabilitation scheme was approved.

11. Any Other Business

(i) Visit by the Hon'ble the Minister of Agriculture and Food

It was decided that the Chairman should invite the Hon'ble Minister of Agriculture and Food to visit the Institute some time in April.

(ii) Bulletins (New Series)

A specimen copy of the proposed new Bulletins was tabled.

(iii) Mr. D. Calnaido, Research Assistant in Entomology; Mr. N. Shanmuganathan, Research Assistant in Plant Pathology

Reported that Mr. Calnaido would be leaving on a Colombo Plan Scholarship for the United Kingdom on the 15th April. He would work under Dr. Mallenby at the Rothamsted Experimental Station.

Mr. Shanmuganathan was also due to leave about May/June and will be working with the Pathologist at the East Malling Research Station.

(iv) **Report of the Co-ordinating Committee**

In reply to Mr. Sanders, the Acting Director said that some of the recommendations had already been implemented. He would, however, give his careful consideration to the implementation of the other recommendations as early as possible. The Administrative Committee would have to consider the question of additional cess required for the implementation of these recommendations.

(v) **Next Meeting**

The next meeting of the Board was fixed for Friday, 5th June, 1959, in Colombo. The meeting terminated at 1-15 p.m. with a vote of thanks to the Chair.

Sgd. *G. A. D. KEHL,*
Secretary.

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